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WATER AND SANITATION FOR HEALTH PROJECT

Operated by
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REPORT ON MOBILE EMERGENCY WATER TREATMENT AND DISINFECTION UNITS

WASH FIELD REPORT NO. 271

JULY 1989

Prepared for the
Office of Foreign Disaster Assistance,
U.S. Agency for International Development
under WASH Activity No. 523

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by

Frederick J. Holland
and
Michael J. Garland

July 1989

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ACRONYMS

A.I.D.	U.S. Agency for International Development (Washington Headquarters)
APT	Applied Project Technologies (manufacturers of the existing MEWTDU equipment)
CDM	Camp Dresser & McKee International Inc.
DOD	U.S. Department of Defense
EPA	U.S. Environmental Protection Agency
gph	Gallons per hour
MEWTDU	Mobile Emergency Water Treatment and Disinfection Units
NCEL	Naval Civil Engineering Laboratories
OFDA	Office of Foreign Disaster Assistance (A.I.D.)
ROWPU	Reverse Osmosis Water Purification Unit
WASH	Water and Sanitation for Health Project

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EXECUTIVE SUMMARY

Purpose

The Office of Foreign Disaster Assistance (OFDA) of the U.S. Agency for International Development (A.I.D.) has maintained emergency water treatment equipment since 1979. The purpose of this report is to review the performance of this equipment, survey similar equipment currently available on the commercial market, survey equipment used by the Department of Defense (DOD), and provide recommendations for upgrading the OFDA response capability.

Mobile Emergency Water Treatment and Disinfection Unit

OFDA maintains eleven mobile water treatment and disinfection units (MEWTDUs) for emergency use. Each unit has a capacity of approximately 2,500 gallons per hour (gph) of potable water. The treatment process consists of filtration and chlorine disinfection. The total transportable weight of each unit is 2,610 lbs.

Based on a site visit and demonstration of a MEWTDU, a review of technical literature and field reports, and interviews with MEWTDU operators, the WASH team concluded that the existing units have performed well with the exception of a few occasions. On those occasions, the following factors have caused poor performance.

1. The units were used to treat raw water with characteristics (high turbidity, high algae content, high iron content) beyond their design capability.

2. The units were located at raw water sources remote from a convenient point of distribution.

3. The units were not equipped with sufficient additional equipment to allow operators to adapt to local constraints.

Department of Defense

The current mobile water treatment equipment within DOD comprises 600 gph and 3,000 gph reverse osmosis water purification units (ROWPU). ROWPUs are capable of producing potable water from fresh, brackish, or salt water as well as water contaminated by nuclear, biological, or chemical constituents.

The 600 gph unit is skid-mounted and weighs 7,300 lbs. The 3,000 gph unit is mounted in a container and weighs 14,800 lbs. The units are generally transported on a trailer or truck. ROWPUs are the most fuel-efficient mobile units producing the highest quality of water from the greatest variety of raw water qualities.

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The most recent development in DOD regarding treatment of non-saline water is a mobile water treatment unit using a diatomaceous earth filter designed for the Navy Construction Battalion. The unit is a self-contained, single-operator, portable, fresh water treatment unit designed to provide 3,000 gph for remote and military use. The unit weighs 730 lbs. and can be transported in the back of a pick-up truck.

The Army is also involved in acquiring an EPA-approved point-of-use chemical treatment process called Chlor-Floc to replace the iodine tablet. The Chlor-Floc tablet is a disinfectant capable of clarifying and disinfecting one liter of non-saline water.

Market Research

The WASH team contacted 45 manufacturers to obtain technical and pricing information on their products. Based on this information, the WASH team chose candidate units that most closely met the requirements of the OFDA. A matrix of alternatives (in the back pocket of this report) was developed to compare the characteristics of the candidate units. Units are classified as either large-group use (600 gph and above), small-group use (1 - 600 gph), and individual use (less than 1 gph).

The candidate units chosen for OFDA consideration are manufactured for military, remote, or emergency conditions. Many units from the industrial, municipal, and commercial market were evaluated but were not chosen as candidates because they were not designed for rugged and remote conditions or for ease of transport.

Recommendations

The WASH team recommends that OFDA upgrade its capabilities and increase its flexibility in providing rapid response to the need for emergency water treatment.

The following is a summary of the WASH recommendations:

1. Upgrade Existing MEWTDU Equipment and Operations

OFDA should develop a program to upgrade the MEWTDU equipment and operation. Chapter 8 of this report lists specific modifications that should be made to the equipment along with estimated costs. The team also recommends that the MEWTDU be operated by an engineer experienced in water chemistry and mechanical technicians capable of operating, modifying, or repairing the units in the field.

2. Evaluate the Goodman Ball 3000-D Unit

The WASH team recommends that OFDA consider the Goodman Ball 3000-D water treatment unit as a supplement to existing MEWTDUs. The Goodman Ball unit meets all of OFDA's requirements regarding size, weight, flow capacity, and

construction. The complete unit sells for approximately $25,000. Technical literature on the Goodman Ball unit is included in Appendix C-1.

As an alternative to purchasing the 3000-D unit, OFDA may wish to develop an emergency response plan with the Naval Construction Battalion which allows OFDA access to the Battalion's equipment. The Naval Civil Engineering Laboratories (NCEL) are conducting tests and evaluations on the unit that may offer further insight into its capabilities. OFDA should contact NCEL and arrange to obtain the test results and discuss the unit's capabilities.

3. Establish a Joint OFDA/DOD ROWPU Program

The WASH team recommends that OFDA and DOD establish a joint program permitting DOD ROWPUs to be used for OFDA operations requiring treatment of brackish and salt water. This program would be developed with the assistance of the Department of the Army, Office of the Deputy of Staff for Logistics, which maintains an inventory of ROWPUs within DOD. Additional assistance could come from NCEL, which also has technical expertise in ROWPU equipment and operation.

4. Develop a Point-of-Use Treatment Program

The WASH team recommends that OFDA develop a point-of-use treatment program that incorporates individual-use equipment. The goal of this program would be to provide potable water in areas where MEWTDU or DOD equipment is not appropriate.

The recommended equipment includes a disposable, individual treatment device like the Water Technology Corporation Personal Purifier Cup or the International Health Systems, Ltd. Pocket Purifier and the point-of-use Chlor-Floc treatment. Chlor-Floc treatment is currently being evaluated by the Army to replace iodine tablets. All of these units are EPA-approved and designed for remote conditions.

Summary

The existing MEWTDU equipment is limited by its original design. OFDA should upgrade the equipment to maximize its ability to meet varying local conditions. In addition, OFDA should take advantage of work by the U.S. Army and NCEL by coordinating the efforts of all of these agencies in emergencies. This coordinated response would allow OFDA to provide potable water to a wider range of people under varying raw water quality conditions at minimum cost.

CHAPTER 1

INTRODUCTION

1.1 Background

A.I.D.'s Office of Foreign Disaster Assistance (OFDA) is equipped to respond to disasters around the world with mobile emergency water treatment and disinfection units (MEWTDUs). This equipment was designed and assembled in the late 1970s with assistance from the Water and Sanitation for Health Project (WASH) and has, with few exceptions, provided satisfactory service. In total, there are eleven units currently stored in Annapolis Junction, Maryland.

The objective of the MEWTDUs is to provide short-term, rapid-response filtered and disinfected water suitable for human consumption to affected persons until the local water supply and distribution system can deliver safe water. The units are intended to be operated by trained U.S. personnel during the initial emergency situation and by trained local people thereafter.

Each mobile unit has a capacity of approximately 2,500 gallons per hour (gph). Based on a nominal demand of 5 gallons per person per day, each unit can serve a population of approximately 12,000. Raw water is filtered to remove particulate matter and disinfected to make it safe for human consumption. Although the original units were equipped with iodine disinfection cartridges, they were subsequently retrofitted for disinfection with calcium hypochlorite tablets in place of chlorine.

According to the User Guide, each unit is stored and shipped in three separate aluminum containers: (1) diesel engine, pump, and controls, weighing 855 pounds and occupying 37 cubic feet; (2) treatment and disinfection equipment, weighing 1,025 pounds and occupying 47 cubic feet; and (3) miscellaneous appurtenances including filters, hoses, and spare parts, weighing 730 pounds and occupying 44 cubic feet. A collapsible 3,000 gallon swimming pool-type storage tank and two auxiliary pumps are also provided.

Either a ten-man crew or lifting gear is necessary to move the aluminum containers. While transport from the United States (where the units are normally stored) to an overseas location can be accomplished quickly, deployment on site can be delayed due to the size and weight of the units and lack of suitable handling equipment. Once set up, the units can be operated and maintained continuously by one person.

Although the equipment performs well, it has certain limitations that prevent OFDA from efficiently providing clean, potable water. These limitations include the size and weight of the units as well as difficulty in treating excessively turbid water and inability to process oily and brackish water. On occasion, OFDA has been misled as to the condition of raw water at the site and has deployed equipment in areas in which the most readily available water was heavily silted, oily, or brackish.

In summary, the OFDA equipment has performed well under design conditions; however, it has limited the ability of OFDA to deliver potable water under conditions that exceed the equipment's capability.

1.2 Water Quality Guidelines

For the purpose of this study, the WASH team used the World Health Organization's Guidelines for Drinking-Water Quality, Vol. 3: Drinking-Water Quality Control in Small-Community Supplies as guidance on water quality standards for emergency conditions. Water quality that meets these guidelines is suitable for human consumption and for all usual domestic purposes.

1.3 Objectives

The objective of this activity, which involved on-site inspection by the WASH team, was to advise A.I.D.'s Office of Foreign Disaster Assistance on upgrading its capability to deliver potable water to displaced persons. The following chapters summarize the findings of the WASH team.

CHAPTER 2

REVIEW OF EXISTING OFDA EQUIPMENT AND PREVIOUS OPERATIONS

On May 3, 1989, Frederick Mattson and Frederick Holland of CDM together with Carole Siegal and Bob Keesecker of OFDA observed a demonstration of the OFDA MEWTDU equipment conducted by Applied Product Technologies (APT), manufacturers of the units. The following is a brief description of the setup and operation of the equipment based on this demonstration, the User Guide to the equipment, and interviews with people who have operated it in emergency situations.

2.1 Mobile Emergency Water Treatment and Disinfection Unit

In general, raw water is taken from a surface water source or, depending on pressure within the system, directly from a distribution system. The treatment process consists of filtration to remove particulate matter from the raw water and chlorine disinfection to kill any remaining bacterial and viral pathogens.

As originally designed, the unit was to receive raw water directly from the water source. Under field conditions that require pretreatment or prechlorination, operators have pumped raw water from the source into a storage tank. Water is then pumped from the storage tank or directly from the unit by a diesel pump into the filtration unit, through an activated carbon filter, and into a storage tank. Chlorine solution is injected after filtration.

Filtration is accomplished by a fine mesh strainer, two prefilters, and the main filter. The main filter consists of 54 Katadyn ceramic cartridge filters. The particulate matter removed from the water accumulates on the outside of the filter cartridges and must be removed by back-washing and hand-cleaning.

Disinfection is accomplished by injection with a calcium hypochlorite solution which is designed to kill or completely inactivate bacterial and viral pathogens. The MEWTDU was originally equipped with iodine resin cartridges. Carbon filters were added after the iodine disinfection to remove any taste and color caused by the iodine. Both the iodine cartridges and the carbon filters were subsequently removed and chlorination was used instead.

Maintenance consists primarily of back-washing the strainer and prefilter, brush-cleaning the final ceramic filters, and maintaining fluids in the diesel engine. The setup/knockdown time of the MEWTDU was reported by the APT operators as 90 minutes on average.

2.2 Previous Operations

Based on discussions with OFDA and information provided to the WASH team, the following list summarizes emergency deployments of the MEWTDUs.

Location	Date	Number of MEWTDUs Deployed
Island of Dominica	7/79	1
Tunisia	11/82	2
Ecuador	1/83	4
Turkey	11/83	2
Mexico City	9/85	2
Colombia	11/85	2
Solomon Islands	6/86	2
El Salvador	10/86	2
Bangladesh	9/88	2

2.3 MEWTDU Operator Interviews

The WASH team conducted interviews with a number of operators of the MEWTDUs. The purpose of the interviews was to obtain information that might assist the team in evaluating the equipment. The following is a summary of the comments resulting from the interviews.

1. Transportation - Size and Weight of Equipment.

All operators reported that the size and weight of the equipment is critical. The equipment must be transportable by a group of people in the event there is no vehicle available or if the site cannot be reached by a vehicle.

The individuals who operated the equipment in Bangladesh reported that they were required to carry the equipment to areas that were inaccessible by truck.

2. Raw Water Conditions.

In Bangladesh, Turkey, and Ecuador, raw water conditions did not permit the MEWTDUs to operate as designed. In Bangladesh, the raw water was extremely turbid and algae-laden and required pretreatment. Pretreatment was not effective due to equipment limitations and to the quality of the water source.

In Turkey, the operator encountered oily raw water that required pretreatment before it could be treated by the MEWTDU. An auxiliary pump was used to pump the raw water into a 3,000 gallon storage tank where the oil and water could separate. The separated water was pumped through the MEWTDU. Once the pretreatment was set up, the units operated well and provided adequate quantities of water.

In Ecuador, the raw water source had a high iron content. The dissolved iron was not removed by the MEWTDU filters. When the water was chlorinated, the iron came out of solution and caused color problems. The operator adjusted the treatment process by chlorinating the water before filtration rather than after. This adjustment removed the color and enhanced filtration.

All of the above examples indicate the need for the equipment to be flexible enough to meet unanticipated local conditions and for the operator to be familiar with water treatment chemistry to permit modification of the treatment process.

3. Distribution of Treated Water.

The operators report that distribution of treated water is generally inadequate during emergency situations. In Bangladesh, the OFDA operators were assisted by the local water authority which had only one distribution truck. If the MEWTDUs had been able to produce the quantity of water anticipated, many more distribution trucks would have been needed. At a second site in Bangladesh, distribution consisted of villagers carrying their water in portable jugs. Overall, the distribution of water was ineffective. In previous deployments, the public was given clean plastic jugs to carry treated water, and these were readily used.

4. Storage Tanks, Diesel Engines, and Pumps.

Operators report that the storage tanks, diesel engines, and pumps supplied with the MEWTDUs are reliable and effective. A gasoline-driven auxiliary pump has been transported with each MEWTDU; it has been recommended that the pumps be driven by diesel fuel to prevent confusion between two types of fuel.

5. Chlorine/Iodine Tablets.

The WASH team received differing opinions on the use of chlorine tablets for point-of-use disinfection. An operator who worked in Bangladesh reported that the local population would not use chlorine tablets out of fear that this was an attempt by A.I.D. to distribute birth control pills. Others associated with the operations in Bangladesh strongly believe that the MEWTDUs are not reliable under the variable conditions that exist during a disaster and that the only way to provide potable water to large groups of people is by point-of-use disinfection.

On the Island of Dominica, water storage tanks were filled with raw water and disinfected with chlorine tablets. The operator reported that this was acceptable to the local people.

2.4 Limitations of MEWTDU Equipment and Operation

In the judgment of the WASH team, the following are the most serious limitations of the MEWTDU equipment.

1. The Katadyn filters severely clog when treating heavily turbid or algae-laden raw water.

2. The MEWTDU is not designed to treat brackish, salt, or oily water.

3. The size and weight of components limit transportation of equipment.

4. The distribution of treated water from MEWTDUs is highly dependent on the selection of the water source and its proximity to those who are to receive the treated water.

CHAPTER 3

DESIGN CRITERIA AND SPECIFICATIONS

From the evaluation of OFDA MEWTDUs and other mobile water treatment units on the commercial market, the WASH team has found that there are three general applications for this type of equipment. In our discussions, we have categorized the equipment as either military, remote, or industrial/municipal. Military equipment is designed by or for the U.S. Department of Defense according to military specifications. Remote application equipment is developed for field and emergency conditions in isolated areas. Industrial/municipal equipment is portable but is generally used by industry or municipalities.

There is also a distinction in the marketplace between raw water treatment (non-saline water) and saline water treatment (salt or brackish water). For military rapid-response water treatment, raw water is generally treated by a pressure or conventional filter process and saline water by reverse osmosis.

Additional specifications for mobile water treatment units include flow capacity, number of transportable components for the unit, weight and size of unit, diesel-driven pump or generator, treatment process train, chemicals used, field storage tanks required, cost, and maintenance.

In our evaluation, we have differentiated among equipment by capacity: large group use, small group use, and individual use. Generally, large group use is considered 600 gph and above; small group use is between 1 and 600 gph; individual use is 1 gph or less.

In reviewing the existing OFDA equipment and operation, the WASH team developed minimum design requirements for large-group use, rapid-response water treatment units that exist in the military or are commercially available.

Type.	Mobile water treatment unit.
Water source.	Fresh, brackish, or salt.
Construction.	Treatment unit shall be contained within a ruggedized frame or mounted on a trailer or skid.
Transportation.	The entire unit, including accessories, shall be transportable in modular components or transportation containers.
Weight.	Modular components or transportation containers shall be transportable by a group of ten persons (unless the unit is trailer mounted).
Operation.	During normal operation, the unit shall be operable by a single individual.
Power Source.	The unit shall be equipped with a diesel engine or generator.

Setup/
Knockdown Time. The setup and knockdown time of the entire unit shall not exceed 90 minutes.

CHAPTER 4

DEPARTMENT OF DEFENSE APPROACH TO RAPID-RESPONSE WATER TREATMENT

The Department of Defense (DOD) has an extensive inventory of rapid-response water treatment units for treating both raw water and saline water. It is our understanding that OFDA has a charter with DOD that permits DOD to lend equipment to OFDA when conditions permit. (See Appendices A and B for a list of DOD contacts and correspondence from the Army.) A survey of the DOD approach may provide information on equipment currently on the market and may offer insight into the possibility of borrowing DOD equipment to expand the OFDA capability. The following is a summary of the DOD approach to individual, small-group, and large-group rapid-response water treatment equipment.

4.1 Treatment of Saline Water

4.1.1 Reverse Osmosis Water Purification Unit (ROWPU)

DOD's focus in field-use water treatment development has been on the reverse osmosis water purification unit, commonly called the ROWPU. The ROWPU is a self-contained, mobile unit capable of treating raw, brackish, saline water and water contaminated by nuclear, biological, and chemical elements. The ROWPU is regarded as the most fuel-efficient mobile unit producing the highest quality of water.

The treatment process used by ROWPU consists of pretreatment, filtration, desalination, and disinfection. Pretreatment of feed water is carried out by the addition of a cationic polymer that permits particles to be filtered that could otherwise not be removed, and use of an antiscalant to prevent dissolved substances from precipitating. The filtration process consists of a multi-media filter and a 5-micron cartridge filter. Following pretreatment and filtration, the water is pressurized before it enters the reverse osmosis elements. In the reverse osmosis elements, the flow is split into two streams, one of product water and the other of concentrated brine. A residual disinfectant (commonly calcium hypochlorite) is injected into the product water before it is stored or distributed.

Depending on the size and weight of the ROWPU (either 600 gph skid-mounted, 9.5 x 7 x 5.7 ft., skid-mounted, 7,300 lbs., or 3,000 gph, 8 x 8 x 20 ft. in a container, 14,800 lbs.), it is generally trailer-mounted and transported by truck or aircraft.

Power is generally supplied to the ROWPU by a 25 kw (600 gph) or 75 kw (3,000 gph) diesel generator mounted on the trailer. Collapsible storage tanks are required for the operation of the ROWPU and are stored on the trailer or in the unit during transport.

Currently, 600 gph ROWPUs are being manufactured and a 3,000 gph ROWPU is being developed for the Army. The ROWPU capacity for treating brackish or raw water is greater than for salt water and varies with the manufacturer. See the matrix

(in the back pocket of this report) for a comparison of ROWPUs manufactured for the Army listed under Unit L5, L6, and L7.

The Army Office of the Deputy Chief of Staff for Logistics maintains an inventory of all water treatment equipment within DOD. According to an executive officer in that office, DOD currently has 600 gph and 3,000 gph in its inventory (Appendix B). The exact quantity of ROWPUs in inventory was not divulged to the WASH team; however, other sources within the military estimate that DOD owns over 650 ROWPUs.

4.1.2 Small Group and Individual Use Desalination Units

A reverse osmosis treatment unit that treats salt water at a rate of 80 gph is being tested and evaluated at the U.S. Army Belvoir Research, Development, and Engineering Center. The unit is designed to supply potable water to a group of approximately 100 soldiers.

The U.S. Army Natick Research, Development, and Engineering Center evaluated a manual reverse osmosis unit that can produce 1.4 gallons per hour. The unit weighs approximately 7 lbs. and is approximately 6 x 26 x 13 in. The unit did not meet the Army flow-rate design specifications. However, Natick has recommended that these units be purchased by the Army until a unit is developed that can meet specifications.

4.2 Treatment of Non-Saline Water

DOD has in the past developed mobile water purification units for large groups that are still being used within the military. The units include a 600 gph and a 1,500 gph Erdlator, a 1,500 gph U-22446 diatomaceous earth filter, and a 3,000 gph Goodman-Ball unit.

4.2.1 The Erdlator

The Erdlator is a mobile water purification unit developed by the Army that can produce either 600 gph or 1,500 gph of water depending on the model. The 1,500 gph Erdlator is mounted on a 2-1/2 ton truck and consists of a generator set, diesel engine, and a cargo trailer. The filtration unit is installed on the bed of the truck and contains the Erdlator assembly, diatomite filter, filter pump, chemical feed equipment, and electrical controls. The 600 gph Erdlator is similar in process train to the 1,500 gph Erdlator with the exception that a generator is not required and the entire assembly is mounted on a 2-1/2 ton, 2-wheel trailer.

Although the Erdlator is no longer manufactured, there are still some units in operation. Most of the DOD Erdlators are in a state of disrepair. The Erdlator is considered an outmoded design for mobile water treatment within both the military and the marketplace. The development of these units and of new technology for mobile raw water treatment in the military has been virtually halted since the advent of the ROWPU. Because the ROWPU is capable of handling

raw, salt, brackish, and fresh water, the military has not improved the Erdlator or promoted its use.

4.2.2 The U-24466 Filter and the 3000-D Goodman-Ball Unit

The U-24466 filter (U-2) is a diatomaceous earth filter developed for the military for portable fresh water treatment. The unit was designed to produce 600 gph to 2,400 gph of treated water. The U-2 is currently unserviceable and obsolete. A replacement for the U-2 has been developed for the Navy by Goodman-Ball, Inc., in California.

Under a contract with the Navy's Construction Battalion, Goodman-Ball, Inc., designed the L1, a 3000-D water purification system as a replacement for the U-2. The unit is a completely self-contained portable fresh water treatment unit that can be operated by one person. It is designed to provide 3,000 gph of water for remote and military use. The complete unit weighs 730 lbs. and is 73.5 x 36 x 43.5 in. The unit is skid-mounted and housed in an aluminum frame that contains all equipment (except storage tanks) and chemicals for complete operation. The treatment process for the 3000-D involves filtration by a diatomaceous earth filter and disinfection by chlorine. The pump is a 2-in. self-priming pump driven by a diesel engine.

The Navy has currently ordered a dozen 3000-D units, and the Marines are considering purchasing some as well. The Naval Civil Engineering Laboratories at Port Hueneme, California, is under contract with the Marines for testing and evaluation of the 3000-D in June or July 1989.

4.2.3 Small Group and Individual Use Non-Saline Water Treatment Units

The Katadyn Pocket Filter has been recently evaluated by U.S. Army Natick Research, Development, and Engineering Center. This filter is for individual use for raw water treatment. It is capable of producing one quart of water per minute. It treats water via mechanical mircofiltration using an approximately 0.2 micron microporous ceramic filter element. Based on the evaluation by Natick, the unit did not meet the Army specification for flow-rate. However, Natick has recommended that the units be purchased by the Army until a unit is developed that does meet Army specifications.

The Army is also actively involved in acquiring a point-of-use chemical treatment process called Chlor-Floc, manufactured by a South African firm and distributed in the United States by Control Chemical in Alexandria, Virginia. The Chlor-Floc tablet is a disinfectant with a flocculent composition that is capable of clarifying and disinfecting one litre of non-saline water. The Environmental Protection Agency (EPA) approved the Chlor-Floc process in February 1989. The Army is currently evaluating Chlor-Floc as a replacement for iodine tablets. It is the only disinfectant tablet being evaluated by DOD.

CHAPTER 5

REVIEW OF EQUIPMENT ON THE COMMERCIAL MARKET

The WASH team contacted 45 manufacturers for technical and pricing information on their products. Based on the information supplied by the manufacturers, the team chose candidate units that most closely met the requirements stated in Chapter 3 of this report.

The evaluation in this report is based solely on information provided by vendors. It must be kept in mind that vendor information can be biased so that caution must be used in its interpretation. Pricing data is only approximate.

The units chosen as candidates for OFDA consideration are manufactured for military, remote, or emergency conditions. The commercial market for portable water treatment units designed for these conditions is much smaller than the market for industrial, municipal, and commercial use. Many units from this market were also evaluated but none met the stated requirements. In general, these units provide state-of-the-art treatment technology. However, they are not designed for rugged and remote conditions or lightweight and compact transport.

The WASH team developed a matrix (in back pocket of report) to compare treatment units and devices that best meet OFDA requirements. Each unit listed is assigned a letter and number identification. The letters L, S, or I represent large, small, or individual group use, respectively. The number following the letter differentiates the units within their use group.

The following is a synopsis of each unit listed in the matrix.

5.1 Large Group Use

Unit:	L1
Manufacturer:	Goodman Ball, Inc.
Model:	3000-D
Type of Device:	Pressure Filter
Desalination:	No
Capacity:	3,000 gph
Cost:	$25,000
Comments:	Unit L1 is described in Chapter 4. It is the only military use, rapid-response unit of its capacity on the market. It can be operated by a single individual and can be transported by hand

by a group of people or carried in the bed of a pick-up truck.

Unit: L2

Manufacturer: Applied Product Technology, Inc.

Model: #SMP-2000-DCPCR

Type of Device: Pressure Filter

Desalination: No

Capacity: 2,500 gph

Cost: Not applicable

Comments: Unit L2 is currently owned by OFDA and was developed by Applied Product Technology. It is included to permit comparison with other units.

Unit: L3

Manufacturer: Water Technologies Corp.

Model: H3000

Type of Device: Pressure Filter

Desalination: No

Capacity: 3,000 gph

Cost: $21,000

Comments: The manufacturer reports that only three of these units have been sold.

Unit: L4

Manufacturer: International Health Services, Inc.

Model: Water Trailer

Type of Device: Pressure Filter

Desalination: Yes

Capacity: 1,200 gph for non-saline, 75 gph for saline

Cost:	$20,000 - 25,000, add $8,500 for desalination
Comments:	This unit can be purchased with or without a trailer. The manufacturer did not provide information on the number of these units in use.
Unit:	L5
Manufacturer:	Engineered Air Systems, Inc.
Model:	ROWPU
Type of Device:	Reverse Osmosis
Desalination:	Yes
Capacity:	600 gph
Cost:	$85,000 - $90,000 (w/o generator set)
Comments:	Manufacturer under contract with the Army to deliver 600 units by May 1990.
Unit:	L6
Manufacturer:	Mechanical Equipment Company, Inc. (MECO)
Model:	ROWPU
Type of Device:	Reverse Osmosis
Desalination:	Yes
Capacity:	600 gph
Cost:	$135,000 (w/o generator set)
Comments:	Manufacturer under contract to assemble 208 units for the Army. To date, 111 units have been delivered.
Unit:	L7
Manufacturer:	Aqua-Chem
Model:	ROWPU
Type of Device:	Reverse Osmosis

Desalination: Yes

Capacity: 3,000 gph

Cost: $350,000

Comments: Manufacturer has developed this unit for the Army. Production has not commenced to date.

5.2 Small Group Use

Unit: S1

Manufacturer: International Health Systems, Inc.

Model: #7006

Type of Device: Pressure Filter

Desalination: No

Capacity: 600 gph

Cost: $1,300

Comments: Designed for emergency and remote conditions.

Unit: S2

Manufacturer: Recovery Engineering, Inc.

Model: Survivor-35

Type of Device: Reverse Osmosis

Desalination: Yes

Capacity: 1.4 gph

Cost: $1,200

Comments: Unit is a hand-held, portable desalinator. It is described fully in Chapter 4.

Unit: S3

Manufacturer: Katadyn

Model: Squad

Type of Device: Pressure filter

Desalination: No

Capacity: 4-6 quarts per minute

Cost: $600

Comments: Unit is a hand-held, portable, remote-use filter. It is described fully in Chapter 4.

Unit: S4

Manufacturer: Water Technologies Corp.

Model: H250

Type of Device: Pressure filter

Desalination: No

Capacity: 250 gph

Cost: Not provided

Comments: Over 20 units have been sold to the Salvation Army.

5.3 Individual Use

Unit: I1

Manufacturer: International Health Systems, Inc.

Model: #7001

Type of Device: Pressure filter

Desalination: No

Capacity: 1 gph

Costs: Not provided

Comments:	Designed for individual soldier use
Unit:	I2
Manufacturer:	Recovery Engineering, Inc.
Model:	Survivor-06
Type of Device:	Reverse Osmosis
Desalination:	Yes
Capacity:	1 quart per hour
Costs:	Not provided
Comments:	Designed for individual use
Unit:	I3
Manufacturer:	Katadyn
Model:	Pocket Filter
Type of Device:	Pressure Filter
Desalination:	No
Capacity:	1 quart per minute
Cost:	$225
Comments:	Unit is described in Chapter 4 of this report.
Unit:	I4
Manufacturer:	International Health Systems, Inc.
Model:	Pocket Purifier
Type of Device:	Filter
Desalination:	No
Capacity:	Capable of treating 100 gallons

Cost: $14

Comments: Disposable unit, EPA approved disinfectant

Unit: I5

Manufacturer: Water Technologies Corp.

Model: Personal Traveller

Type of Device: Filter

Desalination: No

Capacity: 100 gallons

Cost: $20

Comments: EPA approved disinfectant; disposable

Unit: I6

Manufacturer: Control Chemical

Model:

Type of Device: Tablet form disinfectant and flocculent

Desalination: No

Capacity: One litre per tablet

Cost: Not provided

Comments: EPA approved

CHAPTER 6

ALTERNATIVES TO MEET OFDA OBJECTIVES

The following discussion considers the alternatives available to upgrade OFDA rapid-response, emergency water treatment capability. Each alternative is based on WASH team evaluations and inspections of existing MEWTDU equipment and operation, DOD research, and commercial market research.

6.1 Alternative 1 Upgrade Existing Equipment

Alternative 1 involves modifying the existing OFDA MEWTDUs based on recommendations by MEWTDU operators and the WASH team so that the equipment will perform more effectively. Upgrading the existing equipment may increase its reliability under a greater variety of disaster conditions. However, it may not be physically possible to upgrade equipment capability enough to meet OFDA objectives.

6.2 Alternative 2 DOD ROWPUs

Alternative 2 involves the temporary use of DOD 600 gph ROWPUs in lieu of or in conjunction with existing MEWTDUs. This would expand OFDA's capability to treat non-saline and saline water using reliable technology. A disadvantage of ROWPU is that it can only be transported by truck or helicopter.

6.3 Alternative 3 Purchase New Large-Group Use Equipment

Alternative 3 involves the purchase of new large-group use equipment to replace or supplement the existing MEWTDUs. This would increase the capability of OFDA by replacing existing APT MEWTDU units with more reliable, lighter, smaller units.

6.4 Alternative 4 Purchase Small-Group Use Equipment

Alternative 4 involves the purchase of small-group use equipment for deployment in conjunction with the MEWTDU. This would expand the capability of OFDA since a small-group use unit would be lighter and less bulky than a large-group use unit and would be easier to transport. However, large-scale deployment of such units might require a larger number of operators.

6.5 Alternative 5 Purchase Individual-Use Equipment

Alternative 5 involves the addition of individual-use equipment to supplement the MEWTDU. This would upgrade OFDA's capability by providing point-of-use treatment in addition to the MEWTDU. One advantage of point-of-use treatment is that it is a reliable and safe method of treating water in areas where a treatment unit cannot operate. There may be difficulties, however, with cultural acceptance of chemical treatment of water.

CHAPTER 7

RECOMMENDATIONS

The WASH team believes OFDA can upgrade its mobile emergency water supply capability by diversifying its methods of rapid-response treatment. To this end, the team recommends that OFDA develop the following programs.

7.1 Upgrade Existing MEWTDU Equipment and Operation

The existing MEWTDU equipment and operation should be upgraded so that the equipment performs more efficiently. Below is a list of modifications that should be made to the MEWTDU equipment.

A. Implement recommendations from "After-use Analysis of Water Purification Units," Dhaka, Bangladesh, paragraphs B, C, and D.

1. Include a high-volume utility centrifugal pump with a small diesel engine, similar to the engine currently on the units.

2. Include valves (faucets), fittings, garden hose, and piping necessary to attach to each 3,000-gallon water storage tank for utility distribution.

3. Supply each unit with the following extra equipment:

   1 - 1 1/2 in. valve
   1 - 2 in. valve
   1 - 1 1/2 in. gated "Y"
   1 - 2 in. gated "Y"

4. Replace the galvanized pipe foot valves with 18-inch, screwable sections of PVC pipe.

5. Include a 20 lb. bag of alum with each unit.

6. Include five 3-gallon plastic buckets and various sizes of plastic funnels with each unit.

7. Modify the User Guide to remove references to iodine cartridges and the carbon filter. Include instructions on the operation and maintenance of the chlorinator and on restarting the diesel engine in the event the engine runs out of fuel.

8. Develop a pre-use unit inspection procedure and checklist. A unit inspection should be done and a checklist signed before each deployment.

B. Implement recommendations from "Emergency Water Supply Assistance During Floods in Ecuador, December 1982--January 1983" (WASH Field Report No. 74, Chapter 3).

1. Provide the following field test kits with each unit:

   a) Iron
   b) Total coliform, millipore filter

2. Include a "feeder gauge" to be used to determine when filter elements should be replaced.

3. Investigate the redesign of the release system for the pre-filter elements.

4. Investigate the use of a mobile plate settler system for pre-settling.

5. Provide instructions in the User Guide on determining when pre-chlorination is needed and how to do it.

6. Delete from the User Guide instructions on using the aluminum MEWTDU transportation containers to hold water.

7. Provide better quality, more durable, and more accurate pressure gauges.

8. Put stronger handles on the MEWTDU transportation containers, and more of them.

C. Provide sanitary plastic collapsible water jugs (1-to-5-gallon capacity) for distribution of treated water at the disaster site.

The authors of the Bangladesh After-Use Analysis and WASH Field Report No. 74 recommend replacing the existing clear pipe with color-coded pipe, using single-size pipe for both suction and discharge and replacing the corrugated plastic suction pipe with noncorrugated pipe. The WASH team has removed those recommendations from this report. According to Applied Product Technology (APT), color-coded pipe is not available in the pipe material used on the units. APT recommends that the size of the suction and discharge pipe remain different so that they can be easily differentiated in the field. The suction pipe is unique in that it is designed to operate at less than atmospheric conditions and is corrugated to prevent collapse. The discharge pipe is designed to operate at higher than atmospheric pressure and does not require corrugation.

APT estimates that it would cost $35,000 to upgrade the MEWTDUs as recommended. Costs include material and labor necessary to modify each of the eleven MEWTDUs, provide two high-volume pumps, and modify four storage tanks. The WASH team estimates that it would cost $32,500 to update the User Guide. The work would include deleting references to

iodine disinfection, modifications to some of the figures, developing instructions on the operation and maintenance of the chlorinator, and instructions on restarting the diesel engine. Updating the User Guide would also include evaluation and recommendations on alternative pre-filter systems and the use of mobile plate settlers. Collapsible five-gallon plastic water jugs can be purchased at $3 each.

It is recommended that an engineer and experienced mechanical technicians be deployed with the MEWTDUs. The engineer should have extensive experience in water chemistry and be formally trained in MEWTDU operation. The engineer should be responsible for field decisions regarding pretreatment, filtration, treatment process, and site selection. The operator of each unit should be a mechanical technician capable of operating the unit under all conditions and of repairing or modifying the equipment in the field.

The WASH team recommends that OFDA develop a program to implement these modifications. The program would involve developing equipment specifications for the MEWTDU modifications, procuring the specified equipment, and hiring a mechanical contractor to do the work. The program would also involve establishing MEWTDU field staff qualifications and selecting appropriate personnel.

7.2 Evaluate the Goodman Ball 3000-D Unit

OFDA should begin evaluating the Goodman Ball 3000-D unit as a potential replacement or supplement to the MEWTDU. In the judgment of the team, the Goodman Ball 3000-D water filtration and disinfection unit comes closer than any other unit available to meeting OFDA's requirements for a mobile water treatment unit. Its size, weight, flow capacity, and construction are the best on the market today for its type of application.

Testing and evaluation of the Goodman Ball unit for the Marines were done during June and early July 1989 at the Naval Civil Engineering Laboratories (NCEL), Port Hueneme, California. Based on discussions with Ted Kuepper, a project engineer in the Field Logistics Division at NCEL, the test results could be shared with OFDA.

It is recommended that OFDA contact Mr. Kuepper directly to arrange to work with NCEL to gain further insight into the capabilities of the Goodman Ball unit. As an alternative to purchasing the 3000-D unit, OFDA might wish to develop an emergency response plan with the Naval Construction Battalion, which would allow OFDA access to the Battalion's equipment.

7.3 Establish a Joint OFDA/DOD ROWPU Program

The WASH team recommends that a joint OFDA/DOD program be developed that permits use of DOD ROWPUs for OFDA operations requiring treatment of brackish or salt water. The Department of the Army, Office of the Deputy Chief of Staff for Logistics maintains the inventory of ROWPUs within DOD. Correspondence between the Army and the WASH team (Appendix B) outlines what is currently available within DOD.

OFDA should contact NCEL and the Department of the Army, Office of the Deputy Chief of Staff for Logistics, to discuss establishing such a program. It is strongly recommended that Ted Kuepper be involved in this program as he has had extensive experience in the development and operation of the ROWPU within the military.

The following is a partial list of questions that should be addressed in developing the ROWPU program.

- Would military or civilian personnel operate the units?
- What capacity units could be made available to the OFDA?
- From where and how would the units be deployed?
- What would be the limitations of the units available?
- Under what circumstances would the ROWPUS not be available to OFDA?
- What would be the formal procedure for obtaining ROWPUs in times of disaster?
- Under what conditions would OFDA deploy a ROWPU instead of a MEWTDU?

7.4 Develop a Point-of-Use Treatment Program

The WASH team recommends that OFDA develop a point-of-use program that incorporates individual-use equipment. The objective of this program would be to provide potable water in areas unsuitable for a MEWTDU.

Point-of-use treatment might be warranted if a large raw water source is not available or adequate to operate a MEWTDU; if a MEWTDU fails; or where populations are too dispersed to be supplied by a MEWTDU.

The program should further investigate and evaluate the safety and effectiveness of candidate equipment. Candidate equipment includes a disposable, individual treatment device like Water Technology's Personal Traveler Cup or International Health Systems' Pocket Purifier and the point-of-use Chlor-Floc treatment.

Issues to be addressed in developing a point-of-use program include

- Procurement of the treatment devices,
- Storage before deployment,
- Distribution of the devices within the host country,
- Determination of quantity of devices to be distributed,
- Determination of cultural acceptance of treatment, and

- Establishment of conditions under which point-of-use treatment would be implemented.

The use of the Chlor-Floc tablet may not be culturally acceptable in certain cases. OFDA should include a study of the cultural acceptability of the Chlor-Floc method of treatment in the program.

The other individual-use units shown in the matrix were developed for use by soldiers. These units are not recommended for OFDA use because they were designed for specialized purposes and are very expensive.

APPENDIX A

LIST OF DEPARTMENT OF DEFENSE CONTACTS

APPENDIX A

LIST OF DEPARTMENT OF DEFENSE CONTACTS

Mr. Ted Kuepper
Environmental Engineer
Field Logistics Division
Naval Civil Engineering Laboratory
Port Hueneme, CA 93043
(805) 982-5536

Mr. Tom Bagwell
U.S. Army Belvoir RD & E Center
STRBE - FSE Tom Bagwell
Ft. Belvoir, VA 22060-5606
(703) 664-5172

Mr. Mark Smith
U.S. Army Natick RD & E Center
(508) 651-4056

Lt. Wayne Kabat
Department of the Army
Office of the Deputy of Staff for Logistics
Room 1E588
Washington, D.C. 20310-05
(202) 694-3265

Dr. Elizabeth Sutphen
U.S. Army Foreign Science & Technology Center
220 7th Street, N.E.
Charlottesville, VA 22901
attn. AIRTD
(804)980-7435

APPENDIX B

ARMY CORRESPONDENCE

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR LOGISTICS
WASHINGTON, D.C. 20310-05

8 JUN 1989

Army Energy Office

Camp Dresser & McKee International Inc.,
One Cambridge Center
Cambridge, Massachusetts 02142

Dear Mr. Garland:

The current mobile water purification equipment in the DOD inventory is comprised of 600 gallon per hour (GPH), 3,000 GPH and 150,000 gallon per day Reverse Osmosis Water Purification Units (ROWPU). ROWPUs represent state-of-the art technology in water purification which provides fresh drinking water from fresh, brackish, salt, nuclear biological or chemical contaminated water. They require trained and qualified operations and several chemicals to support their operation.

This equipment is designed to operate 20 hours a day at the above stated production rates in fresh water production capacity is reduced up to one third when brackish or salt water is purified.

If the need were ever to arise to use DOD water purification equipment, specific requests should be forwarded through state Department channels.

Sincerely,

Richard P. Holley
Richard P. Holley
Colonel, GS
Chief, Army Energy Office
Directorate for Transportation,
Energy and Troop Support

APPENDIX C

MANUFACTURER CORRESPONDENCE AND LITERATURE

C-1

GOODMAN BALL, INC.

GBC

GOODMAN BALL, INC.

11 May, 1989

Camp Dresser and McGee
1 Cambridge Center
Cambridge, MA 02142

Attn: Mike Garland

Dear Mr. Garland,

Per your request yesterday, we have enclosed a video of our Water Purification unit, and some photos, both of the original design (the grey unit,) and of the new lighter weight improved model (the green unit.)

We have also enclosed some brochures, and our most recent Wholesale Price List. Please note that the $17,500 price mentioned in the video is 4 years old, and for high quantities.

If you need any more information, or have any questions, please do not hesitate to call me.

Thank you for your interest.

Sincerely,

Bill Eldredge
Design Engineer

BE/mb

enc.

3639 HAVEN AVENUE • MENLO PARK, CA 94025 • (415) 363-0113 • FAX (415) 363-8294

GOODMAN BALL, INC.

1500/3000 GALLON PER HOUR WATER PURIFICATION UNIT

Wholesale Price List — Effective 5/5/89

Description	Order Quantity	FOB Factory Sugg. Whsl	Sugg. Retail
Model 3000 D (Gray)	1 - 2	24,411	27,123
	3 - 4	23,823	26,470
	5 - 9	23,270	25,855
	10 - 25	22,161	24,624
	26 - 40	21,053	23,393
	41 - 60	20,499	22,776
	61 - 99	19,945	22,161
Custom Fitted Trailer	1 - 2	1,332	1,480
	3 - 4	1,289	1,432
	5 - 9	1,251	1,390
	10 - 25	1,210	1,345
	26 - 40	1,162	1,291
	41 - 60	1,113	1,236
	61 - 99	1,064	1,182
Standard Supplies Pack (20,000 gallon supplies package)		85.11	94.56

Call factory for optional Mil-Spec finishes, covers and packing.

Prices subject to change without notice

3639 HAVEN AVENUE • MENLO PARK, CA 94025 • (415) 363-0113 • FAX (415) 363-8294

GOODMAN BALL, INC.

INTRODUCTION

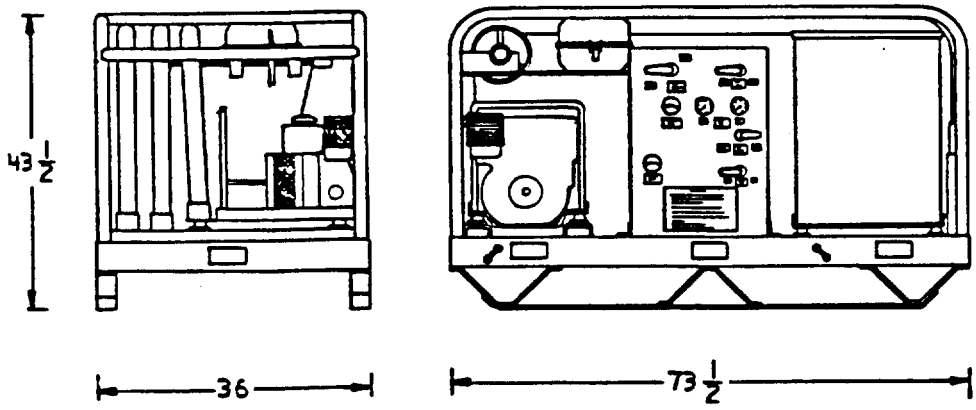
MODEL 3000–D
(PATENT PENDING)

HIGH CAPACITY – FIELD PORTABLE

DIESEL POWER ○ 3000 G.P.H. ○ SELF CONTAINED

A HIGH QUALITY PORTABLE FIELD SYSTEM FOR:

- ○ Military
- ○ Municipalities
- ○ Civil Defense
- ○ Disaster Relief
- ○ Forestry Services
- ○ Resorts
- ○ Hospitals
- ○ Construction Sites
- ○ Fire Services
- ○ Third World Nations



Small in size, yet high in capacity, this uniquely arranged unit is designed to provide water when and where it's needed. It is easily transportable on its own optional trailer, or in the back of a compact pickup, or air lifted by helicopter with its own standard sling. All you need is a water source and a tank in which to store the clean water. Everything else is provided.

GOODMAN BALL, INC.
3639 HAVEN AVE.
MENLO PARK, CA 94025
(415) 363-0113

The 3000–D Water Purification System was developed to provide a fully portable and completely self-contained water purification unit.

As equipped from the factory, this system comes as a single unit with a modular design and contains all the necessary equipment and supplies to provide approximately 20,000 gallons of filtered water. Each optional standard supplies pack will produce an additional 20,000 gallons of water.

The 3000–D was designed to incorporate the following features:

- High capacity – 3000 gallons per hour
- Simple to operate – only one man needed
- Transportable – hand carry, jeep, compact pickup, light duty trailer, fork lift, air lift
- Dependable – diesel powered
- Safe – no gasoline
- Efficient – low cost per gallon
- Training – self-explanatory
- Emergency operation – set-up in thirty minutes
- Reduced maintenance – heavy duty standard components
- Complete – all necessary items included

The approach in design was to simplify servicing in the field. To achieve this, the unit is organized in modules and, where possible, standard components were incorporated in its architecture.

The pump unit can be dismounted in less than five minutes, and as a stand-alone unit, will provide a pumping capacity of 140 GPM while consuming only 0.4 gallons of fuel per hour.

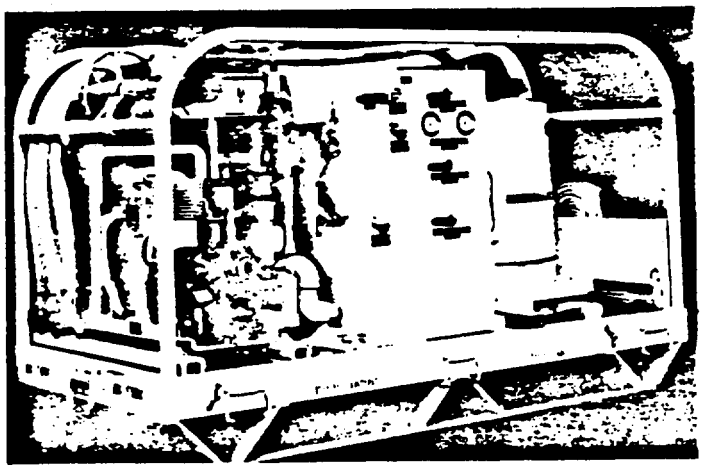
The chlorination and body feed process is precisely controlled from the front panel by our direct proportional water drive feeder system.

Filtration is handled by our high area vertical grid diatomaceous earth (D.E.) filter. Filter coat life is prolonged with our proprietary hydraulic turbine body feed system.

With this system, you are always prepared to GO!

[redacted]

- Diesel Powered
- Stainless Steel Diatomaceous Earth Tank
- Bronze Self-Priming Pump
- Ratio Feeder™ Hypochlorinator
- Removable High Capacity Diesel Pumper
- Modular Construction
- Fuel Container
- All Required Hoses Included
- 50 lbs. Diatomaceous Earth
- Chlorine Granules
- Tool Kit
- Storage Cover
- Integrated Pre-Coat System
- Chlorine Test Kit
- Lifting Sling
- Suction Strainer



OPTIONS

[redacted] (Produces approximately 20,000 gallons of water)

- 50# diatomaceous earth
- 5# chlorine
- 2 gallon fuel container (filled by user)
- Fuel stabilizer
- 1 quart motor oil
- Package size 30" x 18" x 12" approximately
- Weight 65 lbs. approximately

[redacted] (Provides one man portability)

- Water unit mounting system
- Swing down front wheel jack
- 4' x 8' deck
- 1 7/8" or 2" standard ball coupler
- 12" wheels
- Legal lighting for highway use
- Overall length 11'6"
- Overall width 5'4"
- Weight – approximately 275 lbs.

[redacted]

- Additional suction and discharge hoses
- Custom and Mil Spec paints
- Field water tanks
- Auxiliary diesel pump units
- Water analysis kits
- 5 gallon fuel container (fits inside main)
- Storage box mounted on trailer
- Extra heavy-duty military storage cover
- Field spares kits
- Special hose coupling adaptors
- Electric pump drive motor

FEATURES

[redacted]

- Diesel Powered
- Stainless Steel Diatomaceous Earth Tank
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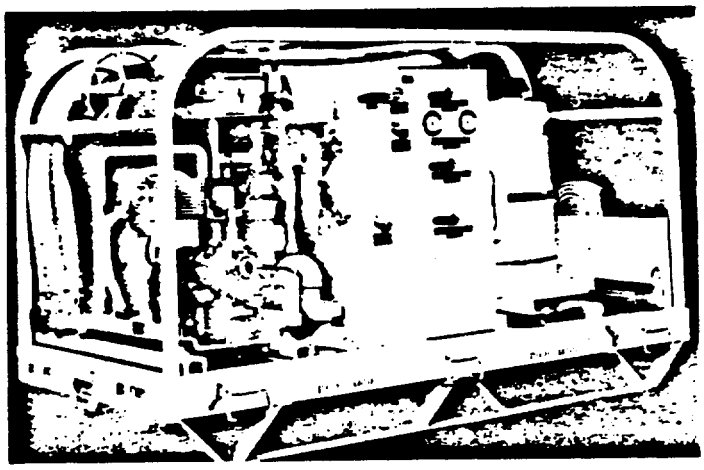

[redacted]

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- 5 gallon fuel container (fits inside main)
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- Field spares kits
- Special hose coupling adaptors
- Electric pump drive motor

[redacted] – Farymann Diesel

14.8 cu. in., lightweight, single cylinder, 4 cycle, air cooled, overhead valve with direct fuel injection.
- o Replaceable aluminum head with cast iron sleeve.
- o Full pressure lubrication with full flow oil filter.
- o Fuel primer and compression release for easier hand starting.
- o Fuel Consumption – 0.4 GPH @ 3600 RPM, 0.3 GPH @ 2500 RPM
- o Develops 5.8 horsepower (DIN) @ 3600 RPM

This power plant offers very high reliability and extremely easy starting.

[redacted] – 2" Self Priming Centrifugal

- o All bronze and stainless steel.
- o 140 GPM as a diesel pump unit, with head capability of over 90 feet.
- o Ball bearing.
- o Seal – carbon, ceramic, stainless steel and viton.
- o Maximum H.P. required is 3.5 @ 3600 RPM.

This pump is a very high grade, heavy duty bronze unit, with a pedestal mount. This configuration promotes extreme ease of service.

[redacted]

- o Automatically precoats filter with the proper D.E. coat to insure proper purification and filtration.
- o Mixes slurry while proportionally injecting D.E. into filter unit.
- o Exclusive turbine drive slurry mix system.

[redacted]

- o Chlorination is directly proportional to water flow through system.
- o Highly dependable drive system uses no external drive mechanism, greatly improving reliability.
- o Adjustable feed rates from 0 to 7.9 PPM, based on a 1% chlorine solution.
- o Very high grade bronze and plastic components with low cost spares.

These are all important reasons why a water driven feeder is utilized.

[redacted]

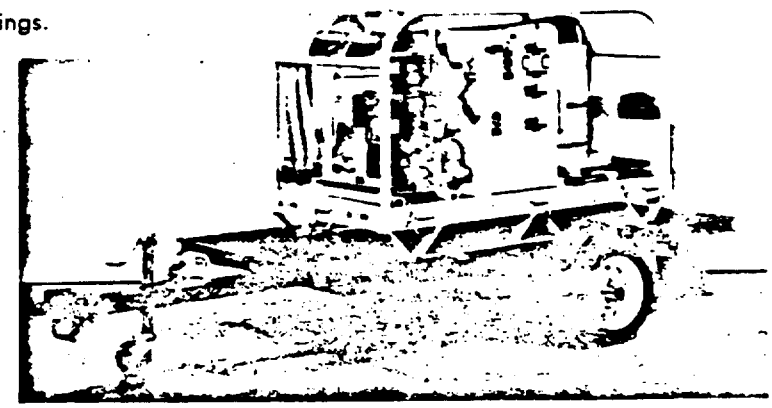
- o Welded aluminum channel main frame.
- o Replaceable "A" skid supports.
- o Replaceable steel skid rails.
- o Tubular aluminum protective cage.
- o Aluminum modular frames.
- o Epoxy prime and polyurethane finish.
- o Stainless steel fasteners.

[redacted]

- o Hoses – suction, discharge, waste.
- o Fuel tank and tool box.
- o D.E. container, and 50 lbs. D.E.
- o 5 lbs. granular chlorine.
- o Suction strainer.
- o Water service hose.
- o Cover.
- o Lifting handles and lifting rings.
- o Lifting sling.

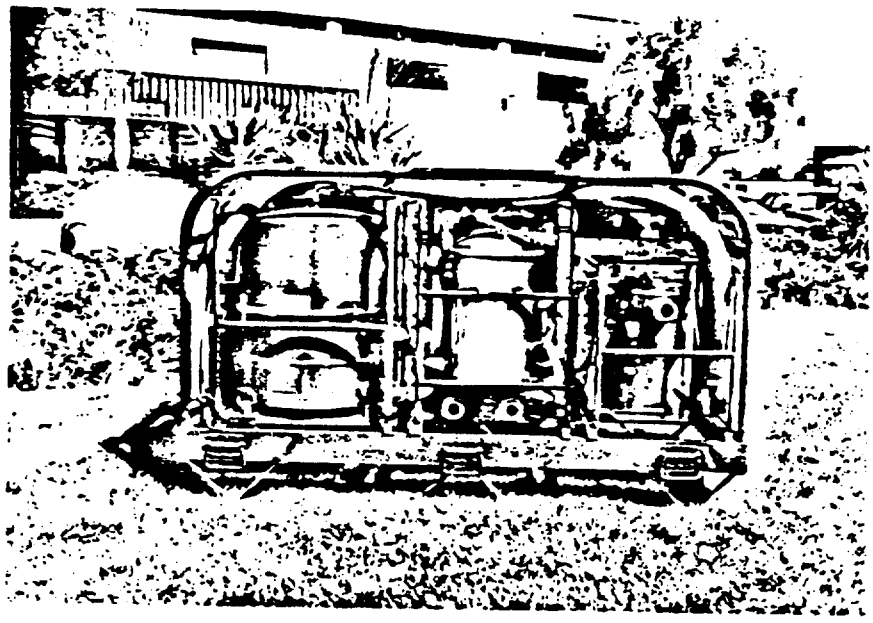
[redacted]

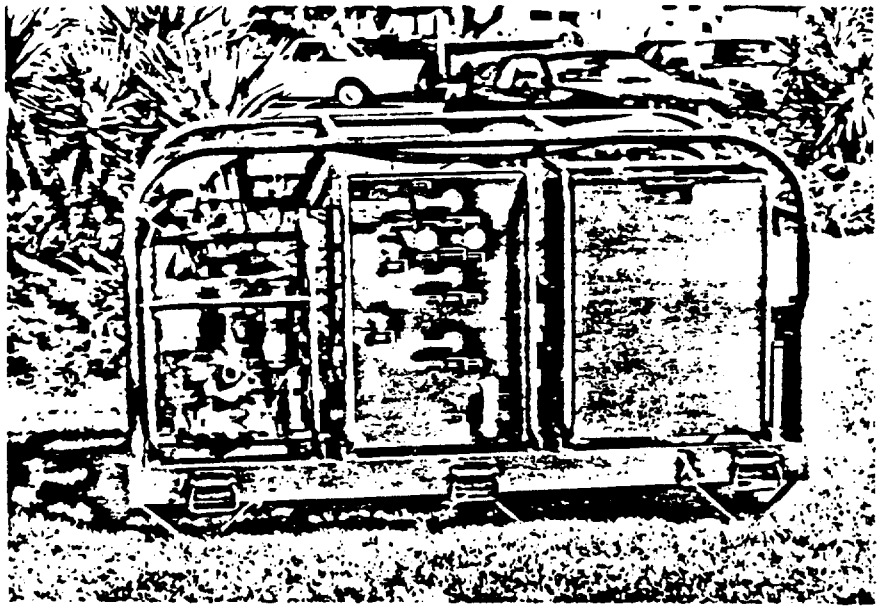
- o Length – 73½"
- o Width – 36"
- o Height – 43½"
- o Weight – approx. 730 lbs.
- o Cubes – 66.6



[redacted] is a registered trademark of H. E. Anderson Co.

SPECIFICATIONS





C-2

INTERNATIONAL HEALTH SYSTEMS, LTD.

INTERNATIONAL HEALTH SYSTEMS, Ltd.
335 Park Street, N.E., Vienna, VA 22180
Phone 703-938-5138 Fax 703-938-5188
703-255-9284 703-255-9285

Camp, Dresser and McKee
1 Cambridge Center
Cambridge, Mass 02142
Attn: Mr. Michael Garland

May 15, 1989

Dear Mr Garland,

In response to your inquiry and kind and perceptive comments I am enclosing herewith detailed data on earlier implementations of our AQUASAFE Portable systems and AQUASAFE Mobile systems for producing safe drinking water at less than 0.2 cents per gallon in the field. Systems are custom designed according to the water quality at the site. They are based on our proprietary ion-exchange resin technology which has been tested extensively and the treated water quality has exceeded United States EPA Standards and National Sanitary Foundation Standard Number 42 (Aesthetic Effects) and Standard Number 53 (Health Effects).

Our special formulation of the POLYHALEX type resin has in several respects yielded superior performance to the Tri-iodide and Penta-iodide resin types. Our modified demand-activated bacteriocidal POLYHALEX resin has been tested extensively by several laboratories and the US EPA and features several advantages for producing drinking water:

- it has a much lower iodine elution (about 0.2 ppm)
  - about one-fifth to one-tenth!! that of earlier resins and is below the 'taste' threshold
- it yields correspondingly higher filter element life-times thus lowering both frequency of replacement and attention and the life-cycle costs.
- it does not require the heavy scrubbing in post-filtering required by resins having high iodine elution and needs only light polishing by the post-filter which is smaller.
- it is more efficient - causing a smaller pressure drop and so does not require the high capacity, energy guzzling pumping systems required by schemes erroneously thought to be competitive merely for being of comparable capacity.

International Health Systems' AQUASAFE Model 7010, is a rugged, modularized, trailer-mounted, self-contained mobile water disinfection unit which can be air-lifted (weighs about 1400 lbs) to emergency sites by helicopter or towed from site to site by vehicle, and quickly set up for operation in minutes. The system can purify water without interruption at a rate of 20 gallons per minute (28,800 gallons per 24 hour period) using a 3 hp. gasoline, diesel, or electric pump or equivalent 'head'from overhead tank.

It is noteworthy that the system may be used without electric or gasoline power in remote locations where wind-driven or horse or ox-driven pumps or waterwheels provide the 'head'. Because the system does not require as high pressures as do the membrane based systems (such as Reverse Osmosis) and the filtration materials are all contained in quickly replaceable cannisters (changed approximately every 1,000,000 gallons of use). Optional desalination modules, fit in the trailer, yielding an additional capability for rendering sea water or brackish water safe for human consumption at a rate of up to 1,800 gals. per day.

The system is an exceptional 'life-saver' device for providing large, continuous quantities of water to disaster relief centers, field hospitals, refugee camps, construction personnel working at damage repair sites etc., where clean and safe drinking water is not available.

The POLYHALEX iodated resin used in AquaSafe products by International Health Systems Ltd. have been tested and found effective against radioactive contamination as shown in the attached test results. In contrast to bacteriostatic systems which involve heavy filtering, usually granualated activated carbon(GAC) to stop the flow of pathogens, the bacteriocidal resins devitalize pathogens - killing viruses and even the larger protozoan cysts and the residual iodine continues the disinfectant action but without the bad taste and odor of chlorine which also has the disadvantage of forming potentially carcinogenic trichloromethane. The superiority over chlorination is also apparent from the attached comparative table.

Please do write or call me if you need further information.

Yours truly,

Raj Edwards

Raj B. Edwards
President

encl: Test results on radio-active solutions
Comparision with Chlorine Treatment Systems
AquaSafe Mobile Unit Providing Drinking Water Lakeside

INTERNATIONAL HEALTH SYSTEMS, Ltd.
335 Park Street, N.E., Vienna, VA 22180
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Camp, Dresser and McKee
1 Cambridge Center
Cambridge, Mass 02142
Attn: Mr. Michael Garland

$29,000 25,000

May 15, 1989

Dear Mr Garland,

In response to your enquiry and kind comments, I am enclosing herewith detailed data on earlier implementations of our AQUASAFE Portable systems and AQUASAFE Mobile systems for producing safe drinking water in the field. These systems are customized for special applications. They are based on our proprietary ion-exchange resin technology which has been tested extensively and the treated water quality has exceeded United States EPA Standards # 3042 and #4052 for safe drinking water

Our special formulation of the POLYHALEX resin has in several respects yielded superior performance to the Tri-iodide and Penta-iodide resin types used on successsfully on NASA missions. Our modified demand-activated POLYHALEX resin has been tested extensively by several laboratories and the US EPA and features several advantages for producing drinking water:

- it has a much lower iodine elution (about 0.2 ppm) - about one-fifth to one-tenth!! that of earlier resins
- it yields correspondingly higher filter element life-times thus lowering both frequency of attention and life-cycle
- it does not require the heavy scrubbing in post-filtering required by resins having high iodine elution and needs only light polishing by the post-filter
- it is more efficient - causing a smaller pressure drop and so does not require the high capacity, energy guzzling pumping systems required by systems of competing capacity.

International Health Systems' AQUASAFE Model 7010, is a rugged, trailer-mounted, self-contained mobile water disinfection unit which can be air- lifted to emergency sites by helicopter or towed from site to site by vehicle, and quickly set up for operation in minutes. The system can purify water without interruption at a rate of 20 gallons per minute (28,800 gallons per 24 hour period) using a 3 hp. gasoline, diesel, or electric pump or equivalent 'head' from overhead tank. The filtration materials are all contained in quickly replaceable cannisters (changed approximately every 1,000,000 gallons of use). Optional desalination modules, fit in the trailer, yielding an additional capability for rendering sea water or brackish water safe for human consumption at a rate of up to 1,800 gals. per day. The system is an exceptional lifesaver device for providing large, continuous

quantities of water to disaster relief centers, field hospitals, refugee camps, construction personnel working at damage repair sites etc., where clean and safe drinking water is not available.

Please do write or call me if you need further information.

Yours truly,

Raj B. Edwards

Raj B. Edwards

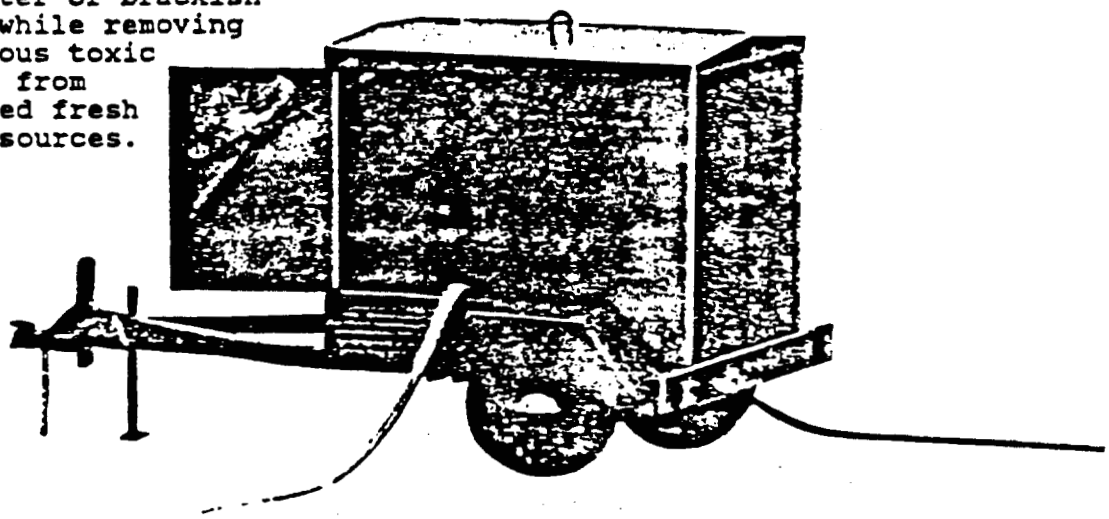
INTERNATIONAL HEALTH SYSTEMS, Ltd.
1950 Old Gallows Road Vienna, Virginia 22180 Phone: (703) 448-7337 Fax: (703) 790-0144

MOBILE WATER PURIFICATION

The world-wide need for potable quality water, for human consumption and use in manufacturing and agriculture, is monumental. IHS has developed the Model 7010 WATERTRAILER mobile water purification unit to answer this need.

The unit incorporates a three stage purification process that provides totally safe, excellent-tasting water. The heart of this treatment system is the revolutionary new Polyhalex resin, a patented biocidal agent that kills all microorganisms such as bacteria, viruses, cysts, protozoa and algae spores on contact. The system also provides sand filtration and activated carbon treatment to remove particulates and organic matter.

The on-board, engine-driven pump is self-priming and provides up to twenty feet of vertical lift. Optional desalinating equipment provides drinking water from sea water or brackish water while removing dangerous toxic metals from polluted fresh water sources.



WATERTRAILER -- IHS MODEL 7010

WHY THE IHS WATERTRAILER IS REVOLUTIONARY

Conventional Purification

Purifying water from surface water sources is usually accomplished by chlorination of the water supply to devitalize all of the microorganisms; filtration to remove sediment and particulates; and finally, activated carbon treatment to remove excess chlorine and objectionable tastes and odors. An alternative process is prefiltration to at least sub-micron levels followed by ultraviolet disinfection. Both processes require extremely large or complex systems which make portability difficult or require great expense to reduce the size. The chlorination process demands a contact chamber to allow the required time for the chlorine to devitalize the bacteria and viruses. It also requires the use of high levels of chlorine and thus the transportation of chlorine in some form. While this process has proven to be successful, the large concentrations of chlorine needed and the large volume contact chambers necessitate very expensive systems. In addition, the activated carbon dechlorination portion of the system is bulky and expensive. Finally, the addition of chlorine to surface waters has been shown to create high levels of trihalomethanes, a group of suspected carcinogenic compounds.

The ultraviolet purification process does not require the large contact chambers nor large activated carbon beds, but does necessitate extremely fine prefiltration to less than one micrometer to guarantee the UV purification capability. This ultrafiltration requires step-by-step staging of the filter process from generally 100u to 50u to 20u to 10u to 5u to 1u. Because these filters are generally cartridge type units, they must be continuously changed or greatly reduced flow rates will result due to the high levels of suspended matter in most surface water sources like rivers, lakes, ponds, etc. These cartridge filters are very expensive, causing the cost per gallon of the finished water to usually be in excess of $0.05 US. In addition, ultraviolet water purification is susceptible to high maintenance requirements due to "blinding" or coating of the ultraviolet tubes by the soluble organic and inorganic compounds in the water. This necessitates the use of mechanical wipers in the system, again increasing maintenance costs.

The WATERTRAILER Solution

The IHS WATERTRAILER represents a remarkable advance over these methods. It is highly efficient, compact in size, requires far less maintenance and is lower in cost. The system is completely mobile and requires only one person to operate it and can produce from one to 20 gallons per minute of purified drinking water from any source.

The source water can be a pond, river, lake, ocean, or the discharge from a sewage treatment plant. Tests have proven that

the IHS WATERTRAILER will process water to meet all bacteriological standards established by the U.S. Environmental Protection Agency, U.S. Health Service, World Health Organization and Canadian Health Agency and thus most, if not all, health organizations throughout the world.

The attached descriptive materials furnish further details covering the system's composition, specifications and operating characteristics. In sum, the system is composed of typical sand filters followed by Polyhalex resin containers and activated carbon filters. The sand filters will remove all particulates down to 20-30 micrometers. These are always provided in pairs to allow the backwashing of one filter with the filter water of the other, while maintaining a flow of filtered water through the remainder of the purification system so that the user is never without a flow of purified water. The filtered water then passes through a cannister of Polyhalex resin which devitalizes all microorganisms upon contact. This includes bacteria, viruses, cysts, spores, etc. Because Polyhalex resin is a demand purification media, little or no residual bacteriocidal matter is passed into the treated water. The water then passes through a final filter unit composed of activated carbon to remove taste and odor causing agents, organic contaminants and any residual iodine.

The result is safe drinking water from any source. Sea water or brackish water can easily be processed with the addition of a reverse osmosis desalination unit to remove excess salts.

GENERAL INFORMATION AND OPERATING PROCEDURE

1. SPECIFICATIONS

A. COMPONENTS

The IHS WATERTRAILER consists of the following equipment and plumbing, from the intake device to the outlet hose:

intake foot valve and flotation device
1-1/4" x 50 ft. polybraided hose
Teel pump with 3 hp Briggs & Stratton engine
pressure relief valve (40 psi)
sample valve and pressure gauge (influent)
1-1/4" x 2 ft. polybraided hose
2 Ampro Century 2000 CB 3015 rapid sand filters
1-1/4" x 25 ft. backwash hose
1" union, socket
1" x 2 ft. polybraided hose
intake manifold for resin cannisters
sample valve and pressure gauge (filtered influent)
3 3/4" True Union ball valves
3 622 Polyhalex resin cannisters (std. length)
in Filterite Housings
3 1C9 Filterite carbon filters in Filterite Housings
3 3/4" True Union ball valves
outlet manifold for resin cannisters
sample valve and pressure gauge (effluent)
water meter
garden hose attachment
shut-off valve
1-1/4" x 25 ft. outlet hose

B. PURIFICATION & FILTRATION SYSTEM

1 Floating water-pickup strainer to access the water source and remove debris from the water system.

2 Sand-media prefilter units inter-connected to allow simultaneous filtering or backwashing of either unit with the filtered water of the other unit.

3 Polyhalex 622 resin cannisters, in parallel to produce micro-biologically pure water.

4 Polypropylene fiber/activated carbon post filters, in parallel to remove organic contaminants, sulfides, objectionable tastes, odors and small particles.

C. WATER PUMP

A gasoline engine drives a self-priming centrifugal pump with a suction lift of up to 20 feet. The clog resistant pump impeller is capable of handling any solids that will pass through the water intake screen. A built-in flapper valve assists in priming. The engine is 3 hp @ 3600 rpm, 4 cycle direct drive. Diesel drive or generator power with electric pump are alternative systems.

D. TRAILER

The trailer provides mobility of the total unit to any location that the towing vehicle can access. Do not exceed a top speed of 45 mph and gross trailer weight of 1,500 lbs. Excessive speed or careless driving could damage the unit and void the warranty. The trailer cap provides protection for the system components and storage compartments for hoses, engine oil, fuel and replacement cartridges. Full height doors give complete access to all operational valves, the engine and the purification modules.

2. SELECTION OF A WATER SOURCE

The standard WATERTRAILER will not process sea water or brackish water. The optional desalinating unit and reservoir must be ordered if salt water or water with toxic metals is to be used as the source. If possible, select a water source that is clear and free-flowing with no apparent floating oil or filamenteous algae. The water intake strainer and hose should be free-floating in the water source. This will insure that the cleanest water from the source will be available to the system. Water with a relatively low turbidity will reduce the load on the system and allow the sand filters to operate longer before backwashing.

3. PROCESS CAPACITY

Polyhalex resin has an extremely high capacity in comparison to common ion exchange resins. The capacity is variable depending upon the concentration of contaminants in the water to be treated; turbidity, suspended solids, iron and the like can shorten the "bed-life" by blinding the surface of the resin beads. Therefore, most water streams should be pre-filtered to achieve maximum resin capacity. The concentration of microorganisms in the feed water is a controlling factor in treatment capacity, but does not exert any potential for bacterial leakage. The three cannisters of Polyhalex resin will process approximately one million gallons of water at a system flowrate of up to 20 gallons per minute.

4. GENERAL MAINTENANCE

Observe all normal precautions and maintenance normally associated with vehicle-drawn trailers. Check tire pressure often and maintain at 30 psig. Lubricate towing lock with every use. Check safety chains and trailer lights each time the trailer is used.

Maintain water pumping system as detailed in the Maintenance Manual. Check the oil in the gasoline engine before each use. Never run the pump dry. Do not exceed 30 psig with the standard sand filters supplied with the unit.

If any of the water valves become hard to turn, loosen union locknut 1/8 turn. If valves leak, hand tighten union locknut until firm. Do not use a wrench; this will damage the valves.

Clean exterior and interior painted surfaces regularly with clean water. A mild soap may be used when the unit is very dirty. The automotive enamel does not require special maintenance.

Make certain that the sand filters are backwashed whenever the pressure drop across the unit exceeds 15 psig. Replace all three of the Polyhalex 622 cannisters approximately every one million gallons.

5. OPERATION SUMMARY

1. Drive trailer to within 20 feet of water source. Uncoil intake water hose and place in at least 3 feet of water.

2. Prime pump by adding water at the screw plug located on top of the pump. Always open either the 3/4" or 1-1/2" valve before starting the pump. Start engine by pulling on the hand cord using the engine choke for cold starts. The pump will begin operation as soon as the engine begins running.

3. Release excess air from systems by opening small valve on top of each sand filter.

4. Operate valves according to diagram A. Change cartridges according to above instructions and backwash sand filters as required for continuous flow of purified water.

5. To stop processing water for a very short period of time, close the system outlet valve. This may cause the pressure relief valve on the pump to operate, discharging water under the trailer. If processing is to be interrupted for more than 2 minutes, shut off the pump.

6. It is recommended that the system be disinfected for storage or periods of non-use. See Operating Manual.

EFFECTIVENESS OF BACTERIOCIDAL RESIN EMPLOYED IN IHS WATERTRAILER

The following results were obtained in tests conducted under the protocols and test procedures stipulaated by METHODS FOR CHEMICAL ANALYSIS OF WATER AND WASTES, USEPA (1979) AND STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER, AWWA (15th Edition):

Microorganism	Water Source or Type	Lab Ref	Challenge Concentration (per 100 ml.)	Treated Water
Escherichia coli	deionized lab	6	190,000	-0-
Pseudomonas aeruginosa	secondary sewage	6	11,000,000	-0-
Escherichia coli	saline	1	1,770,000,000	-0-
Giardia lamblia	tap water	4	2,420	-0-
Vibrio cholerae	Yahara River	7	8,900,000	-0-
Staphylococcus aureus	standing water	3	109,000	-0-
Vibrio cholerae	pond water	5	32,000,000	-0-
Fecaelis streptococcus	raw sewage	2	350,000	-0-
Coxsackievirus	secondary sewage	1	62,000,000	-0-
Poliovirus	secondary sewage	1	45,500,000	-0-
Scenedesmus quadricauda	Fox River	2	present	-0-
Anabena constricta	Fox River	2	present	-0-
Bacillus subtilis	lab water	2	present	-0-
Pseudomonas florescens	tap water	2	500,000	-0-

(1) Loyola University of Chicago
(2) Aqualab Inc.
(3) French Republic-Ministry of Defense
(4) Brigham Young University
(5) International Center for Disease Research, Bangladesh
(6) University of Illinois, School of Medicine
(7) Hazleton Raltech Inc.

Polyhalex

Polyhalex resin can be characterized as a demand Polyhalide converted exchange resin capable of treating microbiologically contaminated water, rendering that water totally disinfected - potable - without discharging toxic residuals into the water being treated. The resin achieves total disinfection by direct contact with the microbiological contaminants.

Completely Effective

Given the proper media bed configuration, the resin will devitalize all microorganisms such as bacteria, viruses, cysts, protozoa and algae spores on contact. Because all available sites on the resin have been exchanged with interhalogen ions during manufacturing, the water flow through the media bed brings microorganisms into direct contact with the resin surface which devitalizes the microorganism.

DEVITALIZES ON DEMAND

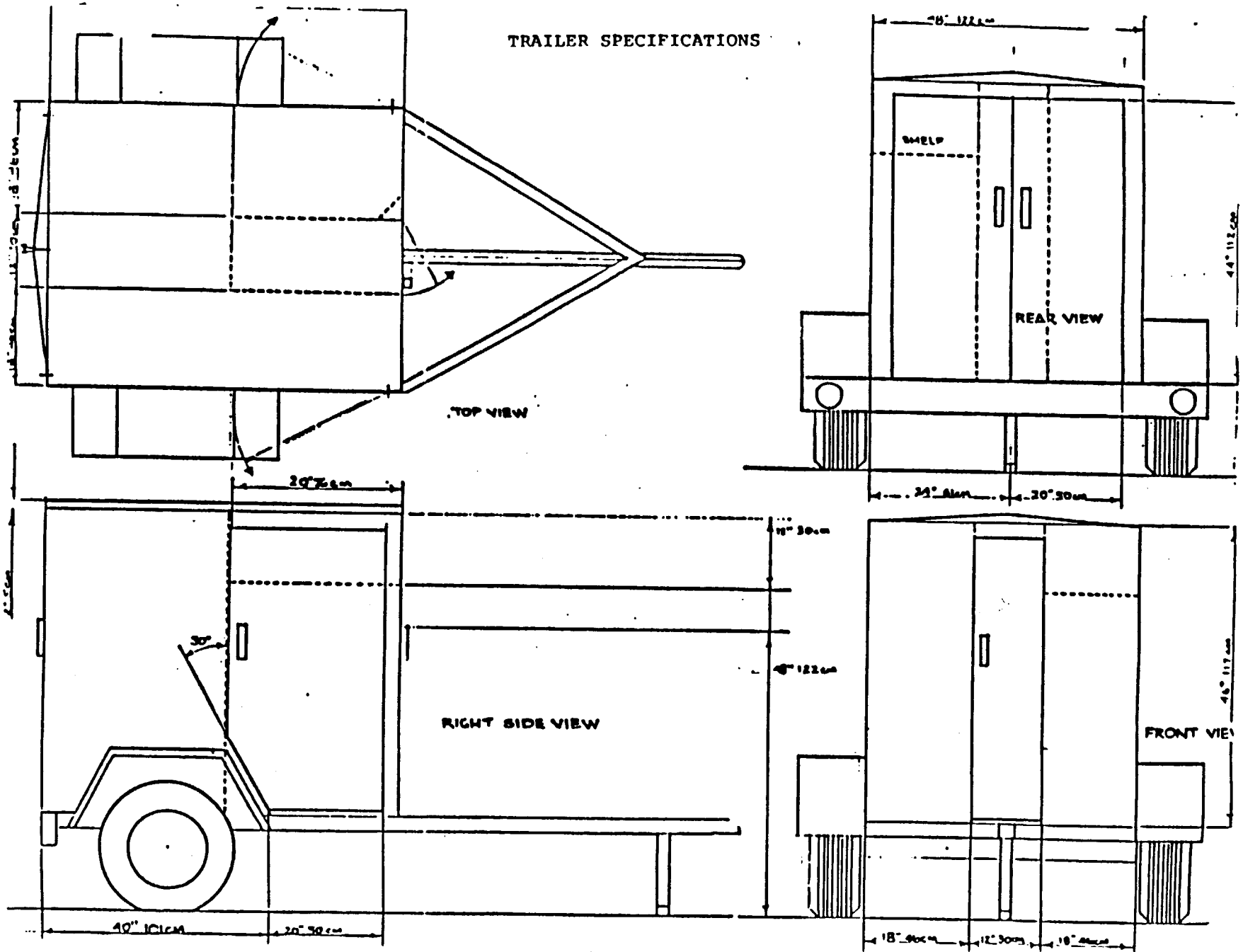
Polyhalex is a demand activated resin. When the resin is brought into contact with a microorganism, it activates itself and destroys the microorganism. At all other times, the resin is inactive and retaining its strength. This promotes a very long, effective product life for the resin.

Non-Toxic and Non-Caustic

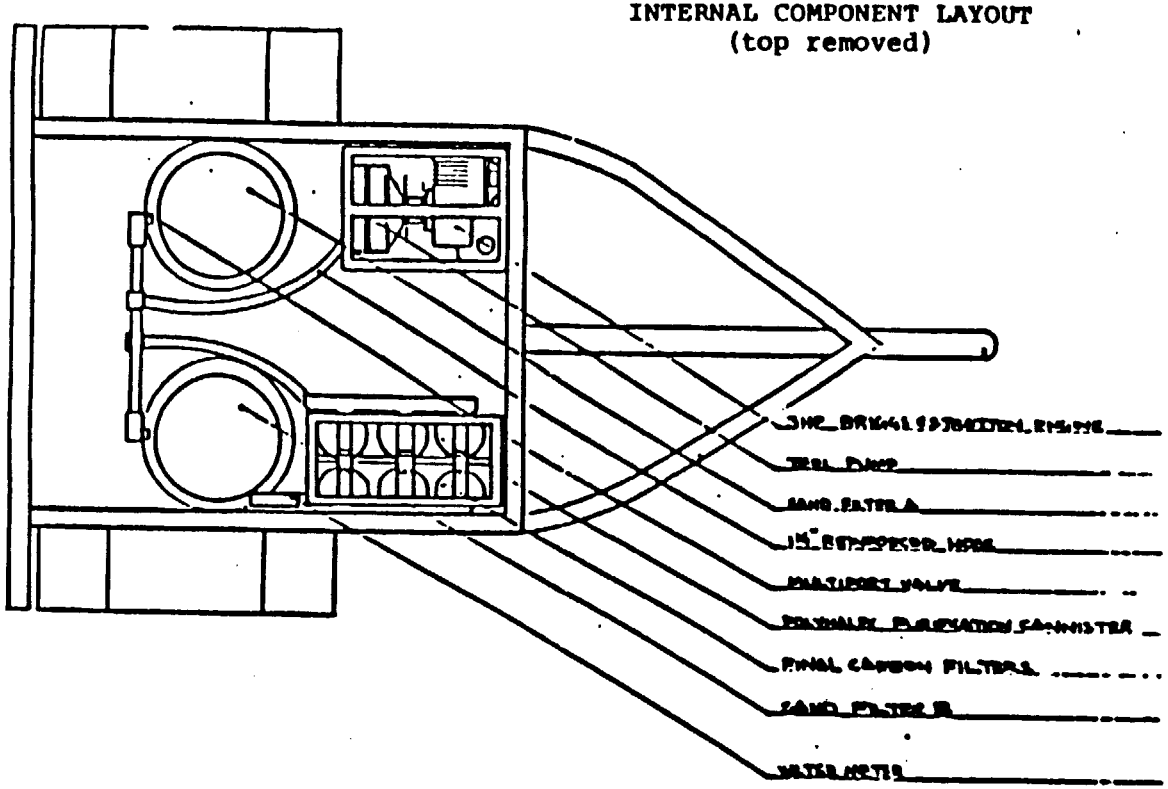
Because of its configuration, Polyhalex is nontoxic and does not elute toxic residuals of any kind. It does not form or cause to be formed, any carcinogenic by-products.

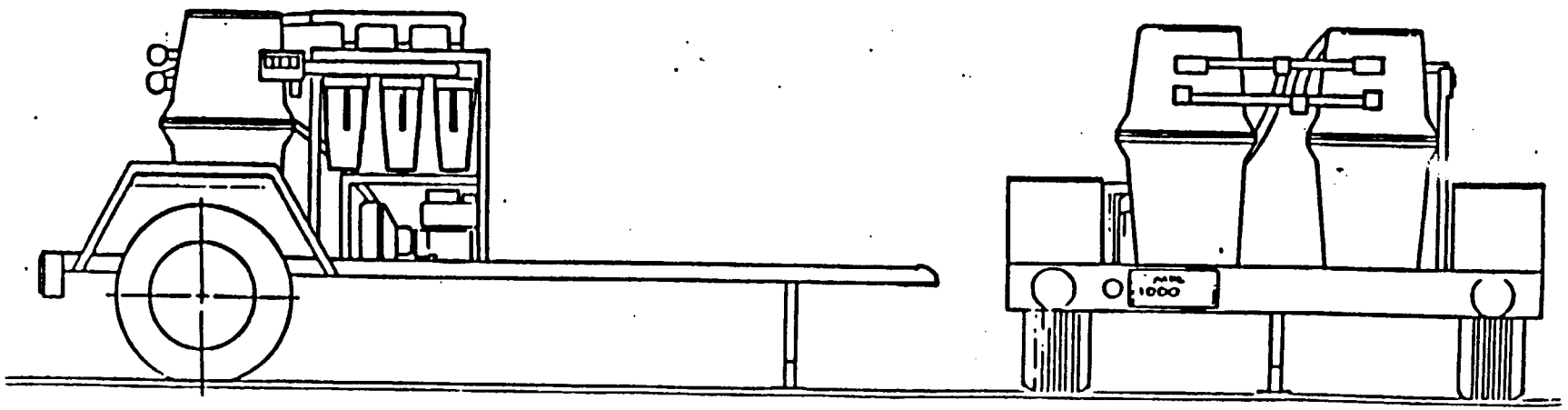
In addition, the resin is non-caustic and will not emit or create any chemical that acts as an oxidizing agent against wood or metal, which is particularly significant in industrial applications.

TRAILER SPECIFICATIONS



INTERNAL COMPONENT LAYOUT
(top removed)





INTERNATIONAL HEALTH SYSTEMS

Aqua Safe™

OFFERS

THE WORLD'S MOST EFFECTIVE

WATER PURIFICATION EQUIPMENT

FOR PERSONAL - HOUSEHOLD - COMMUNITY - COMMERCIAL - GOVERNMENT USE

International Health Systems water treatment equipment uses *iodated resin*—developed from U.S. Space Shuttle technology—which purifies water instantly for drinking, food preparation, and a wide range of medical and industrial uses.

Our products provide 100% kill against all bacteria, viruses, and protozoan cysts, as well as water-borne parasites which cause Guinea-worm disease and other critical illnesses. Our equipment is faster-acting than chlorine and does not require holding tanks, measurement of disinfectant, or monitoring. These are the only point-of-use water disinfection systems capable of meeting the revised U.S. Environmental Protection Agency (EPA) standards.

IHS WATER PURIFICATION PRODUCTS

PATENTED IODATED RESIN ASSURES TOTAL KILL OF ALL WATER-BORNE VIRUSES, BACTERIA, AND CYSTS

ACTIVATED CARBON SCREENS CHEMICAL CONTAMINANTS

IMMEDIATE DISINFECTION—WATER IS INSTANTLY DRINKABLE

NO RESIDUAL BAD TASTE, ODOR, OR COLOR

ONLY POINT-OF-USE WATER DISINFECTION SYSTEMS CAPABLE OF MEETING U.S. EPA STANDARDS

NO CORROSIVE OR TOXICITY HAZARDS

UNLIMITED STORAGE LIFE

NO MEASURING OF DISINFECTANT INTO WATER TANKS—PURIFICATION MATERIAL IS SEALED INTO DISPOSABLE EQUIPMENT OR REPLACEABLE CARTRIDGES

REQUIRES VIRTUALLY NO MAINTENANCE EXCEPT ROUTINE BACKWASHING—RESIN CARTRIDGES CAN BE CHANGED INSTANTLY

VILLAGE-SIZE UNITS REQUIRE CHANGE OF PURIFICATION CARTRIDGE ONLY ONCE EVERY 6 MONTHS-1 YEAR

COST-EFFECTIVE—EVEN LARGEST SYSTEMS OPERATE ON SMALL, ECONOMICAL PUMPS

1-YEAR WARRANTY ON PUMP EQUIPMENT, 30-DAY WARRANTY ON SYSTEMS

IHS PROVIDES ON-SITE TECHNICAL TRAINING, INSTALLATION AND CHECK-OUT

MANUFACTURED UNDER REGULATED U.S. EPA LOT CONTROL PROCEDURES

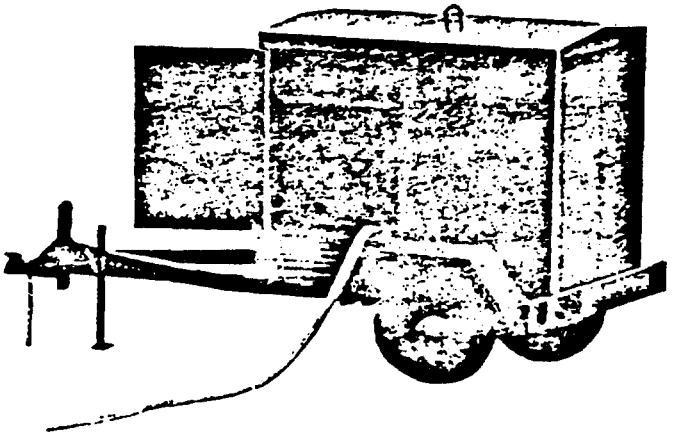
SMALL UNITS READY FOR DELIVERY F.O.B. FACTORY IN 2-3 WEEKS; VILLAGE SYSTEMS AND TRAILERS IN 8-12 WEEKS

MOBILE, HIGH-VOLUME WATER PURIFICATION . . . ANYWHERE REQUIRED . . .

WATERTRAILER
Mobile Water Unit

IHS MODEL #7010

- Provides pure water where needed—avoids having to truck or fly in potable water for disaster relief, field clinics, refugee camps, construction or mining sites, security operations
- Self-contained, compact trailer—can be towed from site to site and quickly activated
- Turns water from any source, even raw sewage, into pure drinking water at a rate up to 20 gallons per minute
- Continuous operation on 3-hp pump—backwashes sediment filters without shutting down
- Up to 20 ft. suction lift—draws water up banks from streams, etc.
- Can treat salt or brackish water up to 1,800 gallons per day with optional desalination module that fits inside trailer
- More effective purification than reverse osmosis units alone which do not screen viruses



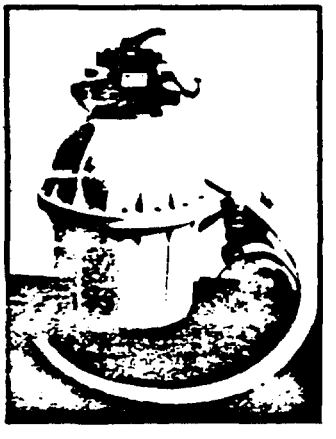
Approximately 30,000 people in the developing world die every day because of inadequate drinking water or sanitation. World Health Organization (WHO) surveys have revealed that 80% of the world's diseases are associated with contaminated water; half of all hospital beds in the world at any time are occupied by people suffering from water-related diseases. At this moment, 400 million people are suffering from gastroenteritis, and 200 million from schistosomiasis. Water-borne infections keep entire rural regions, not just isolated villages, in states of debilitation for decades and represent one of the greatest drains on

MAKES WATER SAFE FOR COMMUNITIES, VILLAGES . . .

WATERWORLD
Village Treatment Unit

IHS Model #7006

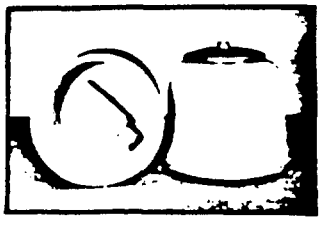
- Purifies water for a village of 1,000 for 6 months-1 year before resin cartridge needs replacement
- Treats water from any village source—surface water, spring-head, rainwater catchment—at a rate of 10 gallons per minute
- Uses standard swimming-pool filter housings—runs on 3-hp diesel, gasoline, or electric pump similar in size to lawnmower engine
- Can operate on gravity flow with 100 ft. + head

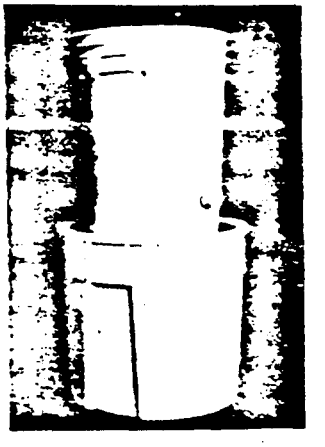


WATERPURE
Disinfection Bucket

IHS Model #7002

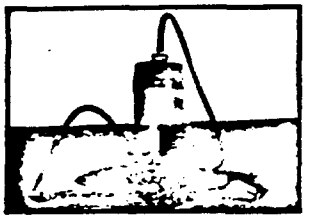
- 3.5 or 5-gallon rugged plastic bucket with screw-in resin cartridge
- Water is purified in the same container it is collected in—solves the problem of spoiling good source water by carrying/storing it in contaminated vessels
- Purification cartridges can also be fitted to most local water jars





productivity and one of the greatest obstacles to economic and social development.

According to a 1982 World Bank estimate, developing countries lose up to $1 billion in lost work days from Guinea-worm disease alone. WHO has chosen Guinea-worm disease as the second affliction after smallpox to be eradicated from the face of the Earth. The UN and World Bank estimate that $300 billion is required to achieve the ambitious goals of the UN International Drinking Water Supply and Sanitation Decade. International Health Systems, Ltd. seeks to employ its revolutionary, cost-effective water purification technology to help reach these goals.



FOR OVERSEAS TRAVEL, CAMPING, OR FIELD USE AT ENGINEERING & MILITARY SITES . . .

POCKET PURIFIER
Personal Drinking Straw

IHS Model #7000

- Disposable purification device that can be carried in pocket/purse/briefcase/knapsack
- Use like regular straw—works instantly, unlike conventional pills/tablets
- No foul taste like iodine or chlorine tablets
- Lasts for at least 100 gallons of use
- Built-in safety factor—sediment/particle filters will clog before germ-killing resin is exhausted

AQUAPORT
Portable Hand Pump

IHS Model #7001

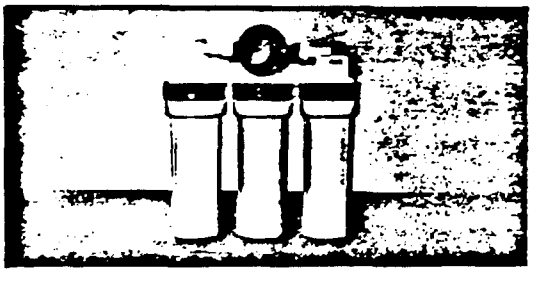
- Protects field personnel from the hazards of biologically and chemically contaminated water supplies
- Purifies up to 1,500 gallons from raw water sources such as streams, ponds, irrigation ditches at 1 gallon per minute
- Disposable unit pumps purified water directly into canteen or jug—no moving parts, no electric power
- Fits in knapsack or on belt or gear-strap (6 x 2.5 in., 1.5 lb.)

INSTALL IN HOUSEHOLDS, HOSPITALS, HOTELS, SCHOOLS, FACTORIES, BARRACKS . . .

AQUASAFE
Plumbing-installed System

IHS Model #7004

- Provides automatic purification of water flow in households or small buildings, or sub-sections of larger buildings
- No modification of existing pipes—easy installation under the sink or on main water line
- Ideal for point-of-use treatment when highest disinfection standards required such as I.V. fluid preparation.
- For industrial-process water with high particle content, can install special sediment filters designed to fit standard housings



AQUATOP
Counter-top Purifier

IHS Model #7003

- Quickly attaches to any faucet by diverter valve—for use as household appliance or as moveable unit in hospitals, etc.
- Delivers pure, sparkling water at the push of a button at one-half gallon per minute
- Replaceable filters, non-corrosive parts
- More reliable, less expensive than bottled water

REPRESENTATIVE MICROBIOLOGICAL TESTING DONE ON RESIN USED IN IHS WATER PURIFICATION SYSTEMS

	EPA STANDARDS	TESTING LABORATORIES				
TEST ORGANISMS	June 1986 EPA Revised Bacteriological Drinking Water Standards for Point of Use Purifiers	University of Health Sciences Kansas City, Missouri	Foster McGraw Hospital Loyola University of Chicago	Hazelton Raltech, Inc. a subsidiary of Hazelton Laboratories of America	Air Force Aerospace Medical Research Laboratory (AFSC)	International Center for Diarrhoeal Disease Research, Bangladesh
	Influent Challenge / Reduction	Influent Challenge / Reduction	Influent Challenge / Reduction	Influent Challenge / Reduction	Influent Challenge / Reduction	Influent Challenge / Reduction
Bacteria						
E. Coli	—	5.0×10^8/L >99.9999%	1.0×10^8/L >99.99%	1×10^7/L 100%	—	4.6×10^{10}/L 100%
V. Cholerae	—	—	—	1×10^7/L 100%	—	3.2×10^8/L 100%
Klebsiella Terrigena	10^7/100 ml 99.9999%	5.0×10^8/L >99.9999%	—	—	—	
Enterobacter Cloacae	—		—	—	38.5×10^8/L 100%	—
Viruses						
Polio Virus	1×10^7/L 99.99%	Testing Underway	1×10^7/L >99.9%	—	—	—
Rota Virus	1×10^7/L 99.99%	Testing Underway				
Echo	—	—	1×10^7/L >99.9%	—	—	—
Coxsachie	—	—	1×10^7/L >99.9%	—	—	—
Protozoan Cysts						
Giardia Muris	10^6/L or 10^7/L*	1.0×10^6/L >99.9%	—	—	—	—

*10^7/L reduction required for units or components based on mechanical filtration particles or spheres, 4-6 microns

IHS TECHNOLOGY

Except for chlorination—which is seldom appropriate for point-of-use applications—existing water purification methods such as activated carbon or ultraviolet radiation do not succeed in killing most viruses, or are inadequate against parasites such as *Giardia*. *IHS proprietary resin* in cartridge or cannister form does not *"filter" out* harmful microorganisms—it breaks down their molecular structure on contact, functioning on a "demand-release" basis. IHS equipment is totally effective against the entire spectrum of water-borne pathogens, including those which cause amoebic and other forms of dysentery, cholera, typhoid, polio, *hepatitis*, schistosomiasis, bilharzia, and dracunculiasis (Guinea-worm disease).

IHS products employ 3 basic *treatment* stages to ensure the safest, cleanest and freshest-tasting water: a sediment/suspended solids filter (ceramic, polypropylene, slow sand or diatomaceous earth depending on equipment size); a second stage consisting of the iodated resin granules which accomplish the bactericidal kill; and a "polishing" stage in which activated carbon fixes common chemical pollutants such as the cholorinated hydrocarbons in pesticides, herbicides and industrial solvents, and clarifies the water for taste, odor, and appearance. Several IHS systems include silver-impregnated carbon to prevent internal build-up of bacteria colonies in the activated carbon.

Thanks to these unique chemical and design properties, IHS equipment can solve a remarkably wide range of problems: prevention of "tourists' diarrhea" . . . preparation of Oral Rehydration Therapy (ORT) solutions for Third World children . . . disinfection of nutrient process water in shrimp farms . . . purification of local water for overseas embassies and holiday resorts . . . to cite just several examples. IHS is prepared to custom-design and build systems to meet particular needs. *Please send us your requirements.*

LOCAL MANUFACTURE

IHS is prepared to explore local manufacture of its water purification products under licensing or joint-venture arrangements, believing this could provide special benefits to a host country including employment, technical and managerial training, technology acquisition, stimulation of component businesses, and export-generated hard currency earnings. The funds required for establishing a fabrication plant are relatively modest. IHS personnel will discuss the feasibility and requirements of such an operation with interested government and private sector parties; and provide assistance to make it a case-study success in its country and region.

For more information or to place orders:

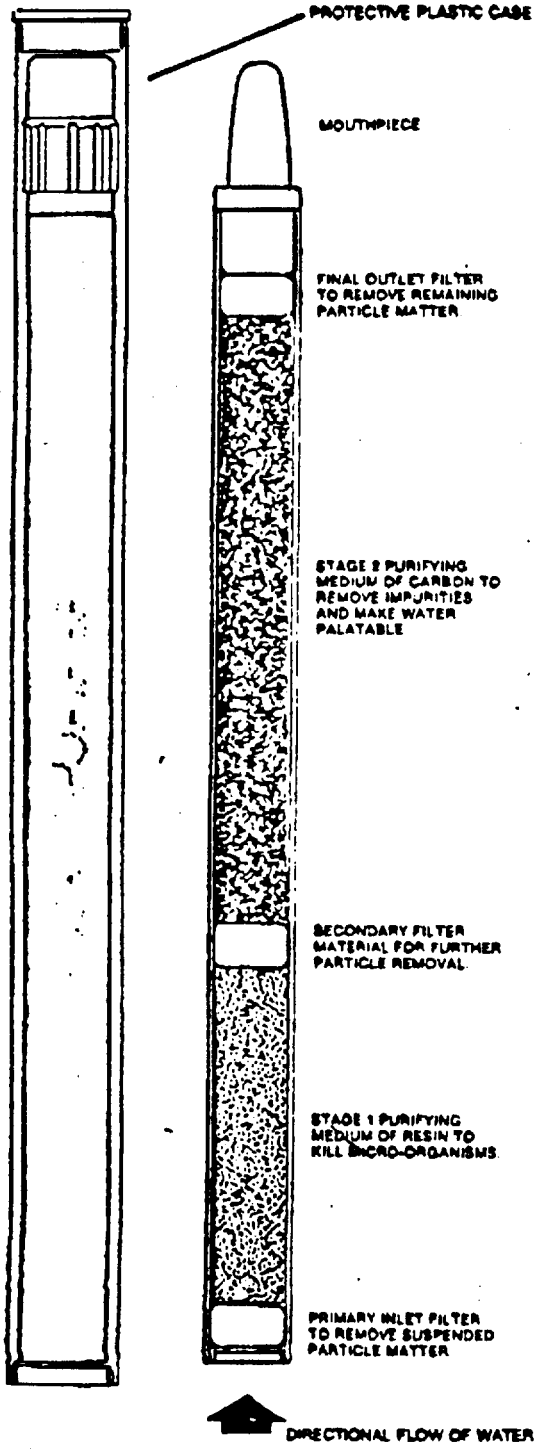
I.H.S., Ltd.
1950 Old Gallows Road
Vienna, Virginia 22180
U.S.A.

Telephone: (703) 448-7337
Fax: (703) 790-0144
or "Attention — I.H.S.", (703) 860-4597
Telex: "Attention — I.H.S.", 36-1119 WU Exec Desk

Sassoon House,
Shirley and Victoria
P.O. Box N3231
Nassau, The Bahamas

POCKET PURIFIER™

ACTUAL SIZE SHOWN



EPA REG. NO. 44919-1
EPA EST. NO. 44919-IL-2
U.S. & FOREIGN PAT. PEND.
U.S. PAT. NOS. 4298478, 4420590

TECHNICAL DATA

I. Purpose:
To provide the user microbiologically potable water from raw water sources such as streams, lakes or ponds that may be polluted with pathogenic microorganisms.

II. Methods of Testing:
The Pocket Purifier™ was tested by simulated-use procedures with raw water from various sources seeded with pathogenic microorganisms. Appropriate analytical procedures given in the Standard Methods for the Analysis of Water and Wastewater. APHA 1975, were employed.

III. Test Results:
The Pocket Purifier™ effectively eliminated the seeded test pathogenic microorganisms from the challenge water in every trial. The residual iodine in the effluent was also minimal. Thus the Pocket Purifier's™ capability of providing good tasting, microbiologically potable water is supported by valid test evidence.

IV. Safety Features:
The design of the Pocket Purifier™ also acts as it's own safety valve. The capacity to purify and disinfect the water is greater than the filtering capacity of each purifier. Thus, before any contaminated water would be allowed to pass through, the filtering capacity would have clogged, and prevented the passage of water.

V. Useful Life Expectancy:
The actual useful life of the Pocket Purifier™ is determined principally by the length of time and periods of use required for the inlet filter to become clogged. This factor is also dependent upon the level of contaminated water being purified and the relative concentration of suspended particle matters in that water. The Pocket Purifier ™ may be stored and reused while still retaining its effectiveness.

VI. Disposal of Product:
At such time that the inlet filter becomes clogged and prevents the passage of water through the tube, the Pocket Purifier ™ should be disposed in the trash.

VII. Particle Retention Rating: 10 microns (nominal)

VIII. Conclusion:
Under the conditions of the simulated-use tests, valid evidence was obtained to conclude that the Pocket Purifier™ is capable of producing microbiologically potable water from a non-saline raw water source.

POCKET PURIFIER™

HAS BEEN TESTED AND SHOWN TO PROVIDE MICROBIOLOGICALLY POTABLE* WATER

- **World-wide application**
- **Easy to use**
- **Small enough to be carried in shirt or jacket pocket**
- **Re-usable until clogged**
- **And best of all . . . inexpensive**

The Pocket Purifer™. A remarkable, scientific breakthrough in personal water purification.

This simple "straw" type device is small enough to be carried on one's person for use in treating bacteriologically contaminated water and rendering that water potable. Lost, stranded, unsure of the water . . . no outdoors person can afford to be without the "Pocket Purifier™".

BUILT-IN SAFETY FACTOR Many other purification devices, which because of their limited purification capacity, can allow the user to drink bacteria laden water without their knowledge. The "Pocket Purifier™" has a built in safety factor to prevent this from occuring. The capacity to purify and disinfect the water is greater than the filtering capacity of the purifier. Thus, before any contaminated water would be allowed to pass through the "straw", the filtering capacity would already have clogged and prevented the passage of water.

EASY TO USE Small, portable, simple to use. The "Pocket Purifier™" should be part of every outdoor persons basic equipment.

After removing the safety cap, simple place the bottom end in water and draw the water through the tube as you would with an ordinary "drinking straw". It's that easy!

The Pocket Purifier™ . . . an inexpensive and convenient means to have potable water.

* **po-ta-ble** (po'te-bel) *adj.* Suitable for drinking: said of water — *n.* Something drinkable; a drink.

C-3

WATER TECHNOLOGIES CORPORATION

wtc
Water Technologies Corporation

Phone (612) 473-1625
FAX (612) 473-1712
WATS 1-(800) 627-0044
Telex 6718379

June 2, 1989

Mr. Mike Garland
Camp, Dresser & McKee
One Cambridge Center
Cambridge, MA 02142

Dear Mike:

I have checked with the previous owner(s) of Water Technologies Corporation and found my statement to you that the Red Cross has used our large systems was incorrect; they have used our cups and buckets in disaster relief efforts, but no larger units.

Several organizations have purchased the H-250 system; the Salvation Army first purchased the unit in 1973 from Water Pollution Control Systems, Inc. (a wholly owned subsidiary of WTC, however no longer in operation) and has purchased approximately 20 additional units since that time. I have located several articles pertaining to their initial purchase and am enclosing copies for your perusal. The product we currently manufacture is much more refined than the model depicted in the 1973 pictures.

For the cost listed on the enclosed price list, the H-250 system can be configured as a stationary unit (as shown in the specification manual) or as a deluxe unit on wheels (as shown in the picture). Please refer to the In-Line replacement components when needing replacement cartridges for the H-250.

The H-3000 model has been purchased for use in remote camp situations, and is used by the United States in its Moscow and Leningrad Embassies to supply entire complexes with drinking water. Unfortunately, I can not supply you with contact names for these customers.

The completely portable H-3000 system -- including diesel power unit -- can be supplied for $22,000; government cost for this unit with a gasoline power source is $21,000. The cost of replacing the Pentacide every 10,000,000 gallons is

14405 21st Avenue North, Suite 120, Plymouth, MN 55447, U.S.A.

$10,000; carbon and sediment filtration components require more frequent replacement, depending on the quality of raw feed water used. Sediment filtration media (sand) can be replaced at a cost of $200; carbon at a cost of $500.

I hope this information is helpful in preparing your work, Mike. Please contact me if you have any questions or would like additional information.

Sincerely,

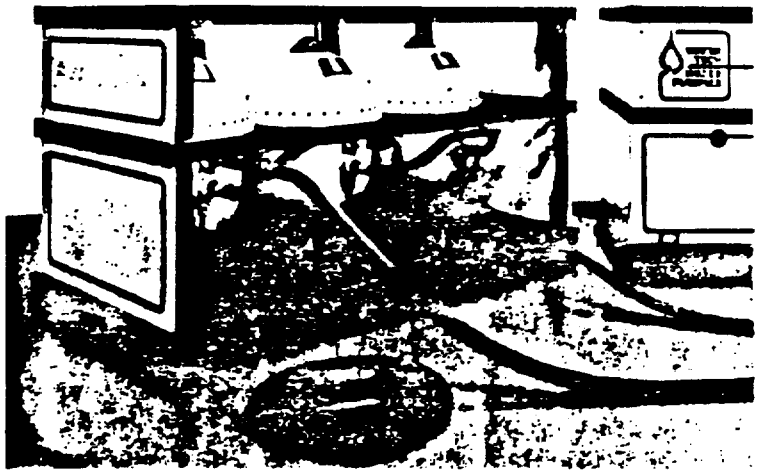
David Botts

David M. Botts
DIrector
Sales & Marketing

DMB/LAP
db81.lp

WATER TECH WATER PURIFIER H 3000

PURIFIES WATER 3000 gallons per hour EMERGENCY or PERMANENT APPLICATIONS



STANDARD EQUIPMENT
- High Rate Sand Filter with control valve
- Activated Carbon Filter
- Pentacide® Purification Chamber
- Electric, 110 volt, 60 hertz, pump motor with centrifugal pump
- Electric control panel with Hour Meter.

OPTIONS AVAILABLE
- Centrifugal Separator for highly turbid water sources
- Gasoline powered pump
- Diesel powered pump
- Hand powered low flow pump
- Gasoline powered 110 generator
- Floodlights.

Purified water for health and safety in a village, a factory, a hotel or when disaster strikes. The Water Tech H 3000 system may be installed in a permanent location to supply purified water to a factory, office plaza or a small village. But the Water Tech H 3000 is also a life saver in an emergency. It is lightweight enough to be moved to remote locations when roads are blocked or damaged. Gasoline or diesel powerplants provide pumping power when electricity is not available.

Water from almost any source is drawn through an optional centrifugal separator to remove any heavy dirt or silt.

A highly effective sand-bed filter removes the dirt still present in the water.

In the second chamber, an upflow bed of activated carbon removes organic materials that cause undesirable tastes and unpleasant odors from the water.

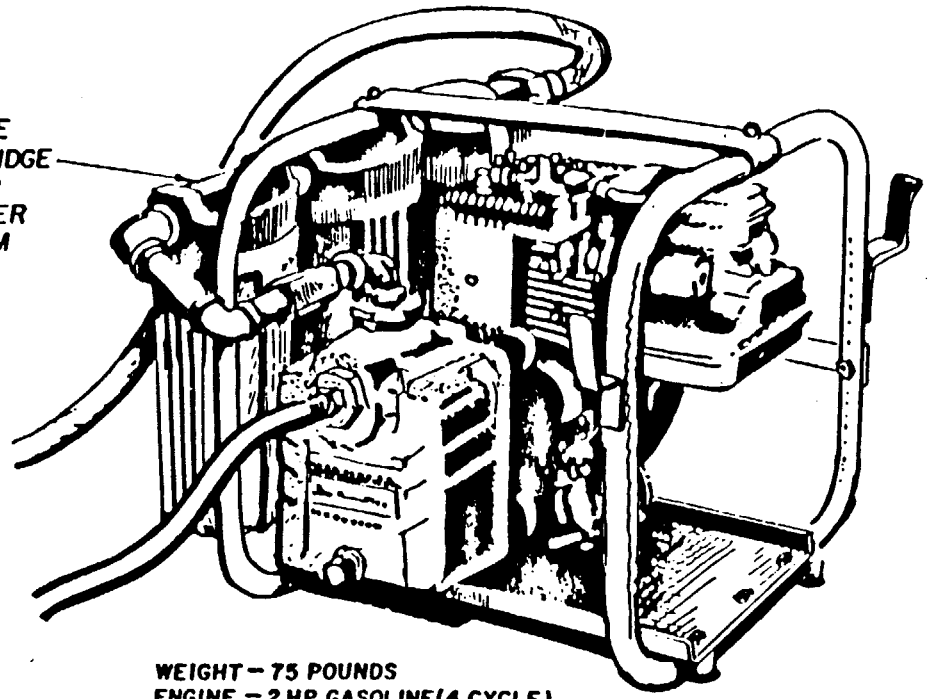
Pentacide® in the final chamber provides complete microbiological purification for up to 3000 gallons of water per hour.

SPECIFICATIONS

Height	55"
Width	93"
Depth	47"
Weight	850 lbs
Flow Rate	3000 gph maximum
Normal Pentacide® life	10 million gallons

WATER TECHNOLOGIES CORPORATION

H-250 PORTABLE WATER PURIFIER



WEIGHT – 75 POUNDS
ENGINE – 2 HP GASOLINE(4 CYCLE)
PUMP – SELFPRIMING,CENTRIFUGAL(30 psi MAXIMUM)
MAXIMUM WATERFLOW-5 GALLONS PER MINUTE
HEIGHT-15 INCHES, WIDTH-15 INCHES,LENGTH-26 INCHES

PART OF H-250

TOLERANCE WHERE NOT SPECIFIED
1 PL. DEC ±
2 PL. DEC ±
3 PL. DEC ±
FRACTIONS ±
ANGLES ±

DRAWN	DATE
CHECK	DATE
APPR DRS	DATE 12-19-86
SHEET OF	
MATERIAL NA	

WTI
1666 Woodland Dr. N
Saline, MI 48176
313-429-5540

PART NAME
H-250 PORTABLE WATER PURIFIER

SCALE ~

PART NO. 250-0000

74

WATER TECH WATER PURIFIER

PERSONAL TRAVELER

Who Uses The Water Tech Water Purifier?

NASA uses the Water Tech Triocide™ resin on all its space shuttle flights to purify and protect the astronauts' drinking water. The **U.S. ARMY** and **AIR FORCE** have approved the Water Tech Water Purifier for sale in all post exchange (PX) stores. The **CANADIAN MOUNT EVEREST TEAM** used the Water Tech Water Purifier to protect their health during an assault on the mountain peak. The **U.S. STATE DEPARTMENT** uses the Water Tech Water Purifier in U.S. Embassies, as well as in homes of U.S. officials living in foreign countries. Major **U.S. CORPORATIONS** use the Water Tech Water Purifier as added "health insurance" for their traveling executives. **BACKPACKERS, CAMPERS, HIKERS AND INTERNATIONAL TRAVELERS** make the Water Tech Water Purifier an essential addition to their travel packs.

TRAVEL HIKE CAMP WITH CONFIDENCE

The Water Tech Water Purifier lets you drink—with confidence—from virtually any non-saline water source, eliminating the threat of illness or disease. Triocide™ devitalizes harmful micro-organisms as they are filtered through the cup's resin bed at a rate of 45 seconds per every 6 oz., resulting in clean, pure drinking water.

The Water Tech Water Purifier safely and easily provides clean, pure drinking water, making ruined vacations a thing of the past.

E.P.A. Registered No. 35917-E

Registered as a water purifier, capable of rendering relatively clear, raw water microbiologically suitable for drinking.

Triocide™ has been proven effective against:

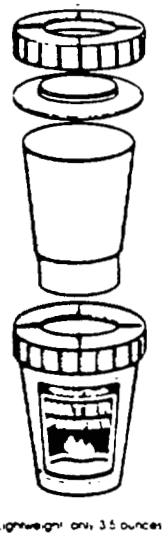
PARASITES	VIRUSES
Giardia Lamblia	L. Scab Polio
E. Histolytica	Newcastles disease
Schistosoma mansoni	Hepatitis
	Polyoma

BACTERIA
Escherichia Coli
Staphylococcus Aureus
Micrococcus Lutea
Salmonella Pullorum
Salmonella Typhimurium
Streptococcus Fecalis
Pseudomonas Aeruginosa

WATER TECHNOLOGIES CORPORATION
14405 21st Avenue North, Suite 120, Plymouth, MN 55447 USA
TEL: 612/473-1625 TELEX: 6718379 FACSIMILE: 612/473-1712

WATER TECH WATER PURIFIER

Safe, pure drinking water wherever you go with the. . .Water Tech Water Purifier



Lightweight only 3.5 ounces

Unscrew COVER

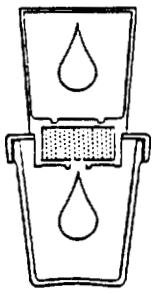
Remove CAP
Lift out the WATER PURIFIER

Put the COVER BACK ON THE CUP

Pour water into the WATER PURIFIER CUP and let it flow into the CUP. Water is now purified and ready to use

Water filters through the resin beads, completely devitalizing harmful micro-organisms. Water is safe, pure and ready to drink.

Safely purifies up to 100 gallons of water



HOW AND WHY THE WATER TECH PURIFIES WATER

When micro-organisms in water contact Triocide™ resin beads, they are instantly rendered incapable of further growth, reproduction or activity. This is accomplished with a high-technology chemical formulation that bonds iodine ions to a sphere of safe and insoluble plastic. The iodine ions remain attached to the sphere and present a devitalizing force to micro-organisms.

To protect the purified water from any possibility of becoming recontaminated, Triocide™ releases a very small amount of pure iodine into the purified water. This is not offensive to taste or smell, and prevents reinfection of the purified water.

The Water Tech Water Purifier is guaranteed to purify 100 gallons of water before it requires replacement.

SPECIFICATIONS:

Material	blue plastic
Weight	3½ ounces
Dimensions	4⅞ inches high 3 inches diameter
Purifier life	100 gallons minimum

STK #	PACK	DEM.	WT.	UPC
100-0000	12	14x10x6.5	5#	10000

WATER TECH WATER PURIFIER

C-4

ENGINEERED AIR SYSTEMS, INC.

ENGINEERED AIR SYSTEMS, INC.
1270 N. PRICE ROAD • ST. LOUIS, MO 63132
(314) 993-5880 • TELEX 44-7108

15 May 1989

Camp Dresser & McKee
1 Cambridge Center
Cambridge, Massachusetts 02142

Attention: Mr. Michael Garland

Dear Mr. Garland:

It was a pleasure meeting you by telephone today. Enclosed you will find literature describing Engineered Air Systems, Inc. (EASI) and our product line.

Of particular interest to you would be our Distribution Systems and our ROWPU. I hope the enclosed product brochures will provide your desired data.

Please feel free to contact me should questions arise.

Very truly yours,

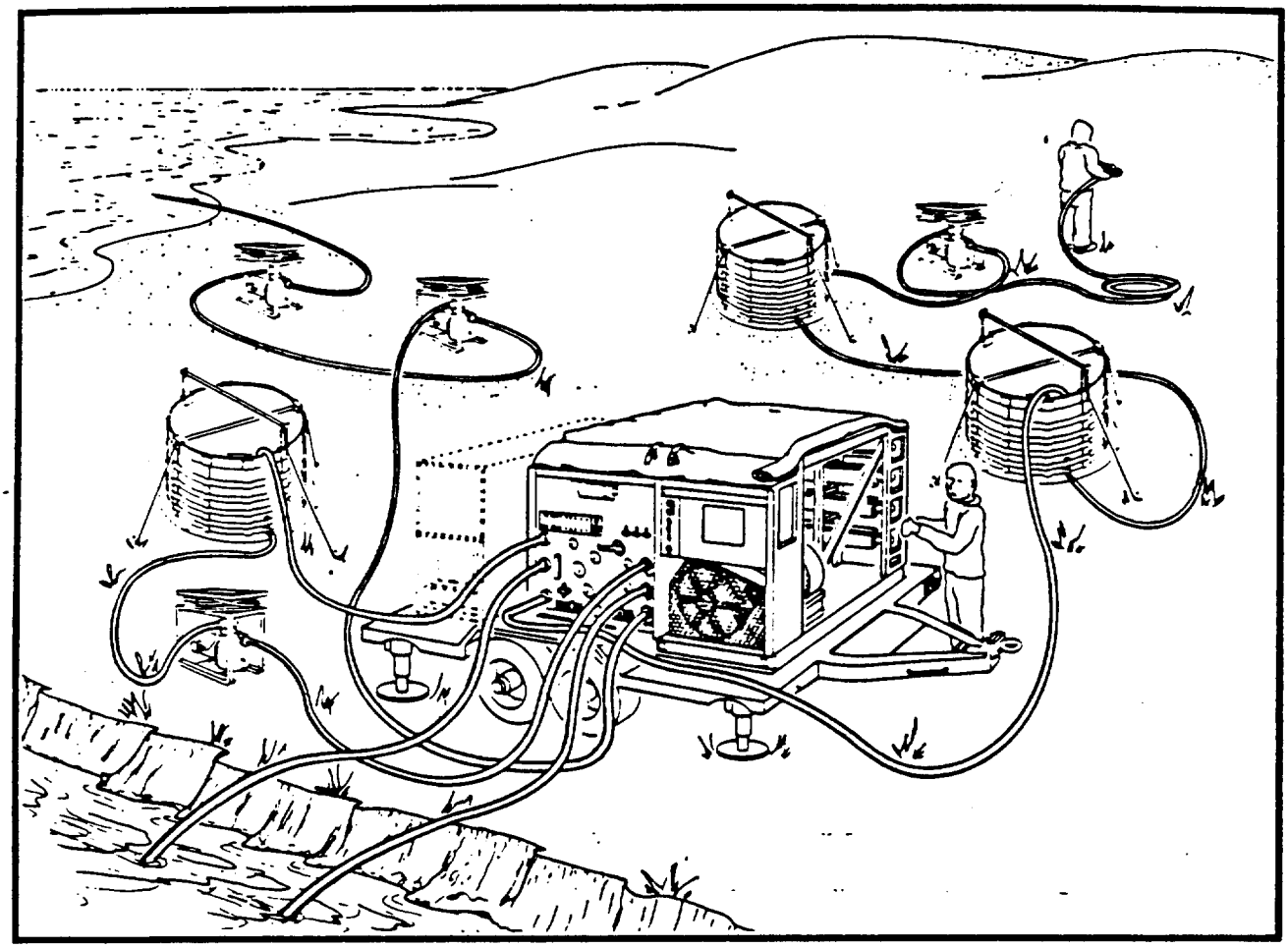
ENGINEERED AIR SYSTEMS, INC.

Ronald W. Davis
Vice President, Field Marketing

RWD:cap

Enclosure

REVERSE OSMOSIS WATER PURIFICATION UNIT



Engineered Air Systems, Inc. (EASI) is presently producing a Reverse Osmosis Water Purification Unit (ROWPU) for use by the U.S. Military. The ROWPU is capable of providing potable water at the rate of 600 gallons per hour from raw water that is highly polluted, turbid, colored, salinized, or contaminated with nuclear, biological, or chemical warfare agents. It offers a fast, reliable method of purifying contaminated water with a minimum amount of maintenance or operator supervision even under adverse weather and climatic conditions.

The ROWPU, which can be powered either through the use of commercial electric power or a 30kw generator set, is lightweight, rugged, self contained, and easily transportable. Most cross country movement is by truck, although the 600 GPH ROWPU can be transported as a sling-load beneath a Chinook helicopter to its emplacement destination.

Two raw water, backwash, and distribution pumps are utilized to provide an integrated system with the main ROWPU unit that allows installation flexibility, high mobility, and reliable product (potable) water output. All hoses, cables, and ancillary equipment to operate the ROWPU are provided (with the exception of the 30 kw generator) in two basic configurations: trailer or skid mounted.

The 600 GPH ROWPU complements the family of water purification and distribution components presently being manufactured by EASI for use by the military services.

ENGINEERED AIR SYSTEMS INC.
1270 NORTH PRICE ROAD • ST. LOUIS, MISSOURI 63132
(314) 993-5880 • TELEX 44-4108

SPECIFICATIONS

DESCRIPTION	600 GPH ROWPU
Product Water (GPH)	600 – 810 *(Note 1)*
Feedwater Flow (GPH)	1800
Weight • Skid Mounted (lbs) • 30 kw Generator (lbs) • Trailer (lbs)	 7300 2850 *(Note 2)* 6825
Dimensions • Skid Mounted Length x Width x Height (ft)	 9.5 x 7 x 5.7
Total Unit • With Trailer Length x Width x Height (ft)	 19 x 8 x 8
Power Requirements • Power (kw) • Voltage (Vac, 60 HZ) • Phase	 22 208/120 3

COMPONENTS		
DESCRIPTION	QUANTITY	CAPACITY
Raw Water Pump • Centrifugal • Motor Drive	2	 30 gallons/min 2 hp
Backwash Pump • Centrifugal • Motor Drive	1	 120 gallons/min 10 hp
Distribution Pump • Centrifugal • Motor Drive	1	 30 gallons/min 1 hp
ROWPU Main Unit	1	

Note 1: 600 GPH using saltwater feedwater
810 GPH using raw, fresh feedwater
Note 2: Optional

ENGINEERED AIR SYSTEMS INC.
1270 NORTH PRICE ROAD • ST. LOUIS, MISSOURI 63132
(314) 993-5880 • TELEX 44-4108

C-5

AQUA-CHEM, INC.

aqua-chem, Inc.
Water Technologies Division

May 12, 1989

Camp, Dresser and McKee, Inc.
One Cambridge Center
Cambridge, MA 02142

ATTENTION: Mr. Mark Garland

Please find enclosed several articles of literature which describe Aqua-Chem's 3000 gph Reverse Osmosis Water Purification Unit (ROWPU).

It is Aqua-Chem's understanding that CDM is presently evaluating various technologies and available equipment to be used in foreign disaster assistance programs. The Aqua-Chem ROWPU unit is an ideal system for this type of application.

The 3000 ROWPU, when fully outfitted, is a self-contained, mobile, highly versatile water purification unit. It can operate on seawater, fresh water or brackish water and has successfully operated at high surf beach sites and at high turbidity (150 NTU) river sites. It is specifically suited to providing combat support water needs where mobility, flexibility, quick setup, and operational simplicity are critical requirements. By incorporating reverse osmosis (RO), the ROWPU reduces the salt content of the product water to drinking (potable) water standards even from seawater. The RO membranes also provide an effective barrier to micro organisms decreasing the critical importance of product chlorination. With the optional NBC system, any anticipated contamination level of nuclear as well as biological and chemical agents will be reduced to well below the long term drinking water limits.

The ROWPU consists of an 8 ft. x 8 ft. x 20 ft. lightweight aluminum ISO container into which is built the equipment, piping and controls necessary to filter and desalt the source water. The container also provides transport storage of accessories, most consumables, the raw water system and the potable water distribution system (if supplied). The ISO container can be mounted on any trailer accepting 20 foot container mounts to provide mobility. The standard trailer for the U.S. Army version is the M871 30-foot trailer. This trailer also accepts the optional diesel generator and NBC post treatment system. With the M871 trailer, the drive away weight is 37,500 lbs. and is within the off-road capability of a standard 5-ton tractor.

210 W CAPITOL DRIVE • P.O BOX 421 • MILWAUKEE, WISCONSIN 53201 • 414-962-0100 • FAX 414-961-2723 • TELEX 26679AQM MIL

aqua-chem, Inc.
Water Technologies Division

After review of the enclosed information, please do not hesitate to contact me at your earliest convenience with any further questions or concerns. Aqua-Chem is pleased to assist you in any way possible.

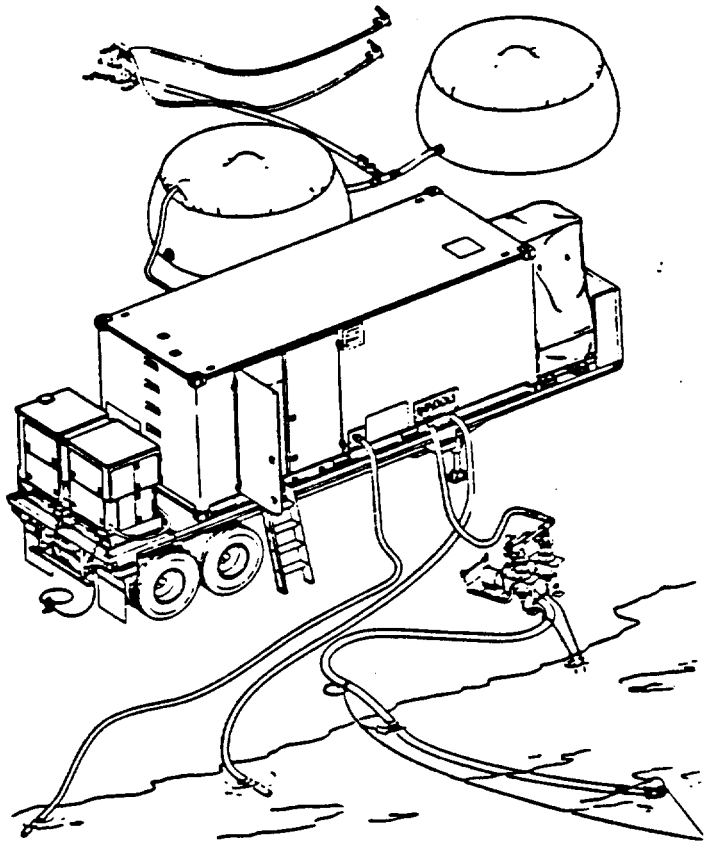
Sincerely,

Patrick DiBenedetto
Sales Manager
Land Based Desalination

PJD-13

MOBILE DEFENSE SUPPORT SYSTEMS

3000 GPH ROWPU SPECIFICATIONS



TITLE

- 3000 Gallon Per Hour (GPH) Reverse Osmosis Water Purification Unit (ROWPU)

CAPACITY

- 3000 GPH at 77°F on Fresh Water Sources and Brackish Water Sources (less than 15000 Mg/l)
- 2000 GPH at 77°F on Seawater Sources (less than 37000 Mg/l)

Telephone: 414-962-0100 Telex: 26679 AQM MIL

aqua-chem inc

WATER TECHNOLOGIES DIVISION
P.O. BOX 421
MILWAUKEE, WISCONSIN 53201 U.S.A.

PRODUCT WATER QUALITY

- Total Dissolved Solids (TDS) less than 1500 Mg/l
- Exceeds all requirements of TB MED 229 for Nuclear, Biological, or Chemical (NBC) Agent levels

RAW WATER CHARACTERISTICS

- Temperature: 32°F to 110°F
- Turbidity: 150 NTU maximum
- SDI: No maximum
- Algae, Bacteria, Virus, etc.: Any level
- NBC Contaminated

OPERATING CHARACTERISTICS

- Temperature: -25°F to +110°F
- Humidity: 14% to 100% relative humidity
- Electrical: Maximum of 62 KW at 480V, 3 phase, 60hz
- Semi-Automatic with manual override
- Continuous operation by one operator
- Unit can be located 200 feet away and 30 feet above raw water source
- NBC post treatment of product water
- Withstand Electromagnetic Pulse (EMP)
- Unaffected by fog, salt-laden air, seawater spray, rain, aerosols, steam, dust, sand and grit
- Army tested (DT II and OT II)

STORAGE CHARACTERISTICS

- Temperature: -28°F to +145°F
- Preservation Plan

DESIGN CHARACTERISTICS

- Trailer mountable or ground set-up
- Dedicated generator or remote power
- Integrally mounted in an 8'x8'x20' ISO Container (NBC Post treatment outside of container)
- Transportable by truck, rail or aircraft
- Set-up or pack-up in 90 minutes
- Container weight: 14,800 pounds
- NBC System weight: 2,600 pounds
- Government programs (reliability, maintainability, human engineering, safety) built in
- 400 hour Mean-Time-Between-Failure (MTBF)
- Manufactured under MIL-Q-9858 QC System

WT 19-3581

aqua-chem inc

MOBILE DEFENSE SUPPORT SYSTEMS

C-6

MECO INTERNATIONAL, INC.

MECO®
MECO INTERNATIONAL, INC.
1300 Thomas Drive • Panama City, Florida 32407
PHONE 904/234-8867

4/10/89

Mike Garland
Camp, Dresser & McKee
1 Cambridge Ctr.
Cambridge, MA. 02142

Dear Mr. Garland,

Enclosed please find two copies of our brochure for ROWPU's (Reverse Osmosis Water Purification Units.) MECO is currently under contract to the US Army to produce the 600 G.P.H. Unit.

You indicated that your need was for quick response disaster aid. The ROWPU is ideally suitable for this.

In addition to ROWPU's MECO is a full line Manufacturer of Water Purification and desalination equipment. We have the capability of designing and producing virtually any size or type you may require.

Our product line includes evaporators as well as Reverse Osmosis systems.

We will be happy to discuss your requirements with you and provide you with equipment which you will be proud to recommend.

Very truly yours,

James A. Kavanagh
Sales Manager Packaged Systems

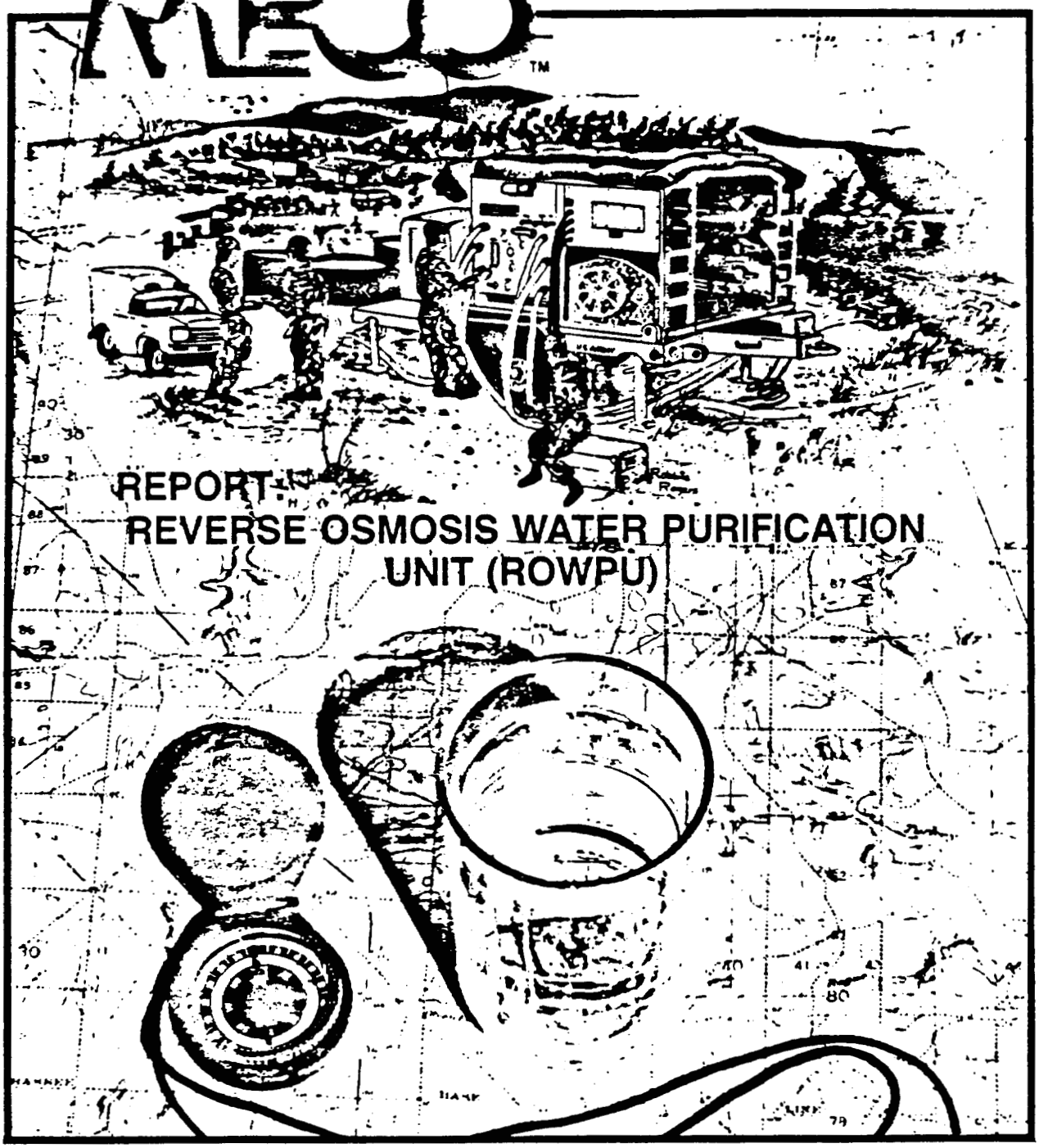
MECO
A World Leader in Sea Water Conversion & Pharmaceutical Distilling Equipment

JAMES A. KAVANAGH
SALES MANAGER
PACKAGED SYSTEMS

MECHANICAL EQUIPMENT COMPANY, INC.
861 CARONDELET STREET, NEW ORLEANS, LA 70130 U.S.A.
TELEPHONE 504/523-7271 TELEXES 58-377 OR 460165
904/234/8867

A Subsidiary of Mechanical Equipment Co., Inc. • 861 Carondelet St. • New Orleans, La. 70130

MECO®™



REPORT:
REVERSE OSMOSIS WATER PURIFICATION UNIT (ROWPU)

GUIDE TO THE EFFECTIVE SELECTION AND OPERATIONAL TRAINING OF EMERGENCY FRESHWATER SUPPLY SYSTEMS FOR ADVANCED DEFENSIVE PURPOSES.

PREPARED BY: MECHANICAL EQUIPMENT COMPANY, INC.
861 CARONDELET STREET
NEW ORLEANS, LOUISIANA 70130

WATER, THE ESSENCE OF LIFE...BUT ONLY IF IT IS PURE

We normally take good water for granted. However in its absence we quickly begin to comprehend how vital quality water is to our survival.

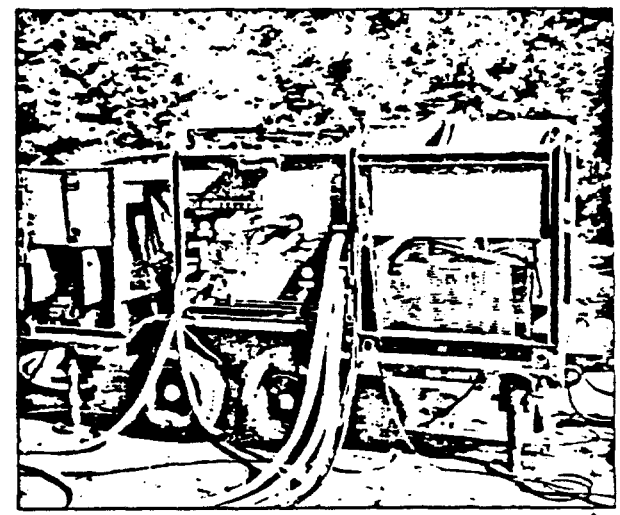
Earth, the "Blue Planet", has 70% of its surface covered with water, yet most of it is actually deadly for human consumption. The capacity to insure or re-establish a supply of quality water is vital to a nation's survival. Mechanical Equipment Company's (MECO) Reverse Osmosis Water Purification Unit (ROWPU) can help provide this capability.

The compact water making system can produce 600-3000 gallons of quality drinking water per hour depending upon which system is selected. MECO ROWPU means freshwater from seawater, highly polluted lakes or streams, salty desert wells or water contaminated with nuclear, biological or chemical warfare agents.

A disaster can strike suddenly creating unbearable situations. Preparedness can counteract some of the consequences of such a catastrophe. There will be enough health hazards without introducing the additional problem of waterborne diseases.

Originally developed for the US Army by the Belvoir RD & E Center, ROWPU has undergone significant developmental improvements under MECO's experienced hands. MECO's version of ROWPU is extremely durable and highly corrosion resistant. The 600 ROWPU withstands a 25g force drop. This provides it with airdrop capabilities for remote area deployment.

The extent of the strategic military advantage for having a reliable source of good quality water may not be immediately apparent.



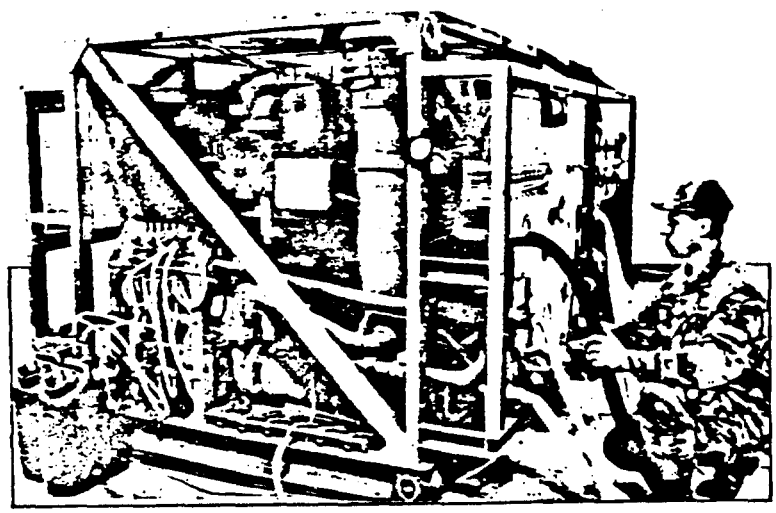
600 GAL PER HOUR US ARMY ROWPU WITH OPTIONAL GENERATOR SET

History has shown man's ultimate survival and morale in a combat zone depends either directly or indirectly upon his supply of water. Without water a soldier can succumb to heat prostration within hours of strenuous physical effort. Studies show there is no substitute for a supply of freshwater in keeping soldiers at peak proficiency.

Subsequently extra water needs were formulated by the US ARMY for use in drinking, all cooking, laundering, and bathing. Furthermore, significantly increased water requirements are demanded when environmental protective suiting is worn, due to heavy loss of body fluids.

During World War II several systems were developed for providing freshwater to battlefield troops. MECO is proud to have been a supplier of those early efforts. Our continued research, development and manufacturing in the field of desalination provides expertise not found in many desalination equipment manufacturers.

Natural disasters frequently cause contamination of conventional water supplies. The casualties resulting from water diseases far out number those caused by earthquakes, typhoon, volcano etc. Such emergencies were part of the design criteria for the MECO ROWPU. The availability of ROWPU's could save thousands of lives during and after future disasters.



3000 GPH ROWPU UNDER OPERATION

MECO ROWPU, A PRIMARY SOURCE OF WATER

ROWPU can change a contaminated swamp, river or ocean into freshwater within 2 hours after deployment. The self-contained ROWPU produces, in almost any condition, a constant flowing stream of pure water ready for human consumption or storage. ROWPU was designed to provide the US Army a primary source of freshwater for troops in battlefield situations. ROWPU has proven itself capable during a wide variety of battlefield exercises and emergency conditions.

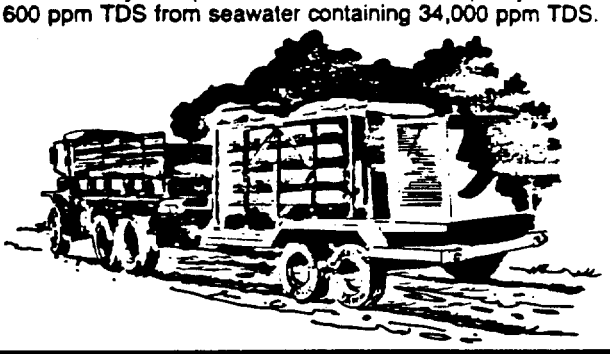
FLEXIBILITY • RUGGEDNESS • DEPENDABLE

With today's worldwide mobility, a modern army can frequently find itself isolated from its support group. Therefore any equipment taken into such locations must meet certain design criteria. Such a system must be simple, lightweight, reliable, rugged, self-contained, and able to be transportable through rough terrain and by diverse means.

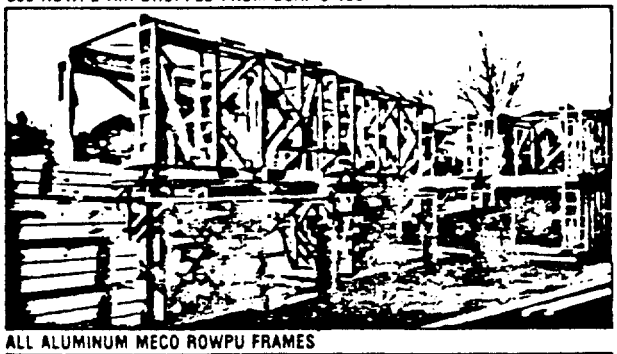
Those design guidelines were very demanding. Nevertheless it was imperative to our fighting men that they be accomplished. MECO's ROWPU manufactured for the US Army, meets the critical demands of advanced combat deployment and disaster preparedness.

The US Army used many ROWPU systems in meeting its potable water requirements during the Gallant Eagle 86 exercise. ROWPU systems provided the hundreds of thousands of gallons required to fulfill their needs during the exercise. This recent large scale deployment confirms the invaluable uses of the new technology of ROWPU during actual combat simulation exercises.

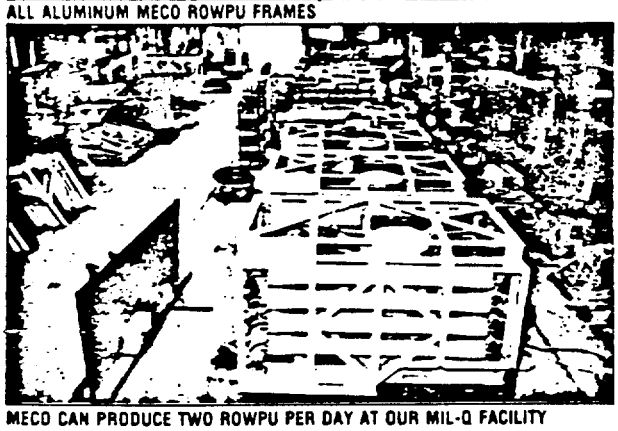
ROWPU's product water during the exercise was far under the recommended allowable level for human consumption of 1500 parts per million (ppm) Total Dissolved Solids (TDS). The entire system produced an overall water quality of 500-600 ppm TDS from seawater containing 34,000 ppm TDS.



600 ROWPU AIR DROPPED FROM USAF C-130



ALL ALUMINUM MECO ROWPU FRAMES



MECO CAN PRODUCE TWO ROWPU PER DAY AT OUR MIL-Q FACILITY

REVERSE OSMOSIS

Reverse osmosis (RO) allows salty water under high pressure, in excess of osmotic pressure, to come in contact with a semipermeable membrane. Pure water or almost pure water passes through the membrane and exits the system under atmospheric pressure. This selective separation process is carried out at ambient temperature and therefore requires less energy than most other methods.

Multimedia filtration removes suspended particles entering the system through the input strainer. The cartridge filters remove suspended solids that pass through the multimedia filter. The high pressure positive displacement feed pump produces hydrostatic pressure against the membranes causing a separation in salty vs freshwater to occur. RO can recover thirty to eighty percent of the feedwater as product water.

Raw water increases in salt concentration while passing across each RO membrane in series, then is discarded as brine. Product water passes through each membrane at a constant flow. The chemical system injects chlorine into the product water preventing reinfection during storage.

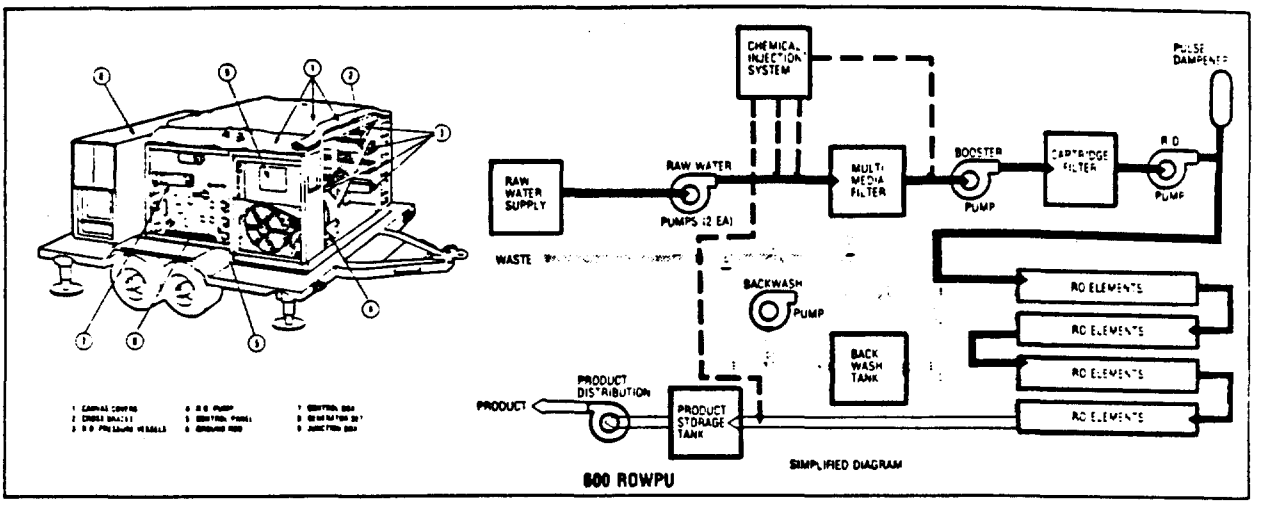
ROWPU FEATURES

The US Army system concept for ROWPU is to provide an emergency water system. MECO's ROWPU is such a system and will produce safe drinking water during almost any adverse condition, anywhere in the world.

Located within the framework are the main components of the system: multimedia filter; booster pump; cartridge filter; high pressure pump; pulse dampener; pressure vessels (containing the membrane elements); chemical injection system; piping; electrical system and control panel. ROWPU includes a distribution, backwash, and two raw water pumps, each in aluminum frames with power cables.

Membranes, the heart of the system, are synthetic elements enclosed in fiberglass pressure vessels. Each membrane element is contained inside a pressure vessel.

Raw water is pressurized by the high pressure plunger pump, capable of producing a discharge pressure of up to 1400 psig depending which system is selected. A pulsation dampener reduces pressure fluctuation caused by the positive displacement pumping action. This eliminates the hammering effects on piping, membrane elements and related instruments, increasing their meantime between failure (MTBF).



600 ROWPU

The chemical injection system uses a pump with four liquid heads and independent controls for each liquid injection. Chemicals pumped from four 5 gallon plastic containers, marked for their usage, have separate level indicators.

To remove nuclear or biological chemical contamination from product water, a Nuclear Biological Chemical (NBC) post treatment system is provided.

SIMPLICITY OF OPERATION

MECO uses virtually identical operating and instrumentation packages for each of its known ROWPU models.

The simplicity of ROWPU's instrumentation facilitates ease of operation. The operator panel consists of: a pressure gauge; three pressure differential (delta-P) gauges; four flow meters and one 3-way backwash valve. Indicator lamps located on the control panel show the status of each major component.

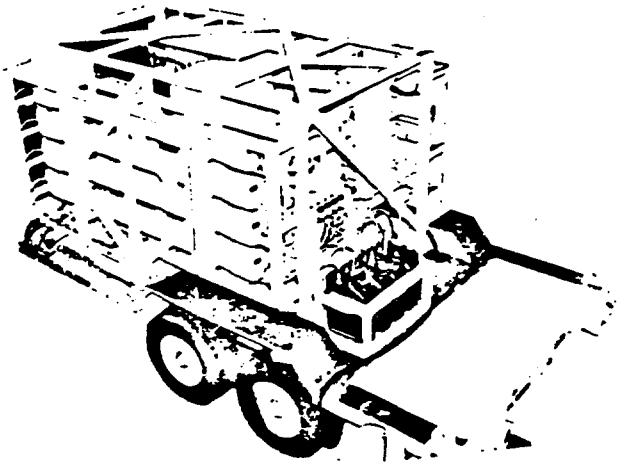
Solid state multimedia backwashing is completely automatic after an initial manual selection in backwash mode.

The backwash pump, distribution pump and two raw water pumps are self-contained in their own frames with covers.

The layered overpack contains: a full complement of tools; chemical test; regents; hoses; spare fittings; measures; tubing. ROWPU provides as standard supplies, one complete set of spare cartridge filters and sufficient chemicals to start up and operate ROWPU for 200 hours of continued operation. All ROWPU models are available in either trailer or skid mounted configuration.

The towing vehicle supplies 24 volts to the specially designed trailer. The trailer is supplied with: air-actuated brakes; a lunette 'pintle hook-up; four leveling jacks and swivels. It has a Trunion axle suspension, rated at 5 tons.

Power is supplied to ROWPU by an optional generator set, or equivalent (see specs). Power connects to the junction box by way of designated external connecter plugs.



MECO 600 ROWPU WITH COVER REMOVED—OPERATING

MECO ESTABLISHES EACH ROWPU'S DEPENDABILITY

MECO QUALITY

MECO establishes each ROWPU's dependability by six rigorous hours of testing under actual operation, meeting nine stringent quality assurance levels. Each fully assembled MECO ROWPU must pass 192 separate pre-test and 35 post-test quality assurance checks. All ROWPU components are thoroughly inspected against specifications before accepting them in MECO's inventory.

MECO 600 ROWPU SPECIFICATIONS

SYSTEM

OUTPUT	TDS ppm	USGPM	LPM	POWER REQUIREMENTS	
PRODUCT FROM SEAWATER	350-1500	10	38	SYSTEM	29 KW MAX
PRODUCT FROM BRACKISH	50-500	10	38	VOLTAGE	200/230-3ph
PRODUCT WITH NBC INSTALLED	4-5	10	38	FREQUENCY	60 HZ
RAW WATER	—	35	132		

PUMPS

PUMP	USGPM	LPM	PRESSURE		HP@RPM	MOUNTED		
			PSIG	KPa		MAIN FRM	OWN FRM	CLOSE CPLD
RO HIGH PRESSURE	33	125	980	6760	20@1175	X		—
RAW WATER (2 EA)	30	113	45	314	2@3450		X	X
BACKWASH WATER	120	454	70	483	10@3500		X	X
DISTRIBUTION (PROD)	30	113	23	156	1@3450		X	X
BOOSTER	30	113	23	156	1@3450	X		X

WEIGHTS AND DIMENSIONS

ITEM	LENGTH		WIDTH		HEIGHT		WEIGHT	
	ft	m	ft	m	ft	m	lb	kg
600 ROWPU	9.5	2.9	7.0	2.1	5.6	1.7	5900	2678
OVER PACK	—	—	—	—	—	—	1800	816
TRAILER*	19	5.8	8	2.4	3.2	.9	5600	2540
600 ROWPU & TRAILER GEN	19	5.8	8	2.4	8	2.4	17000	7711

*MAX TOW SPEED: 50 mph (80 kph); 24V-DC; LUNETTE HITCH HGT 2.4-2.9ft

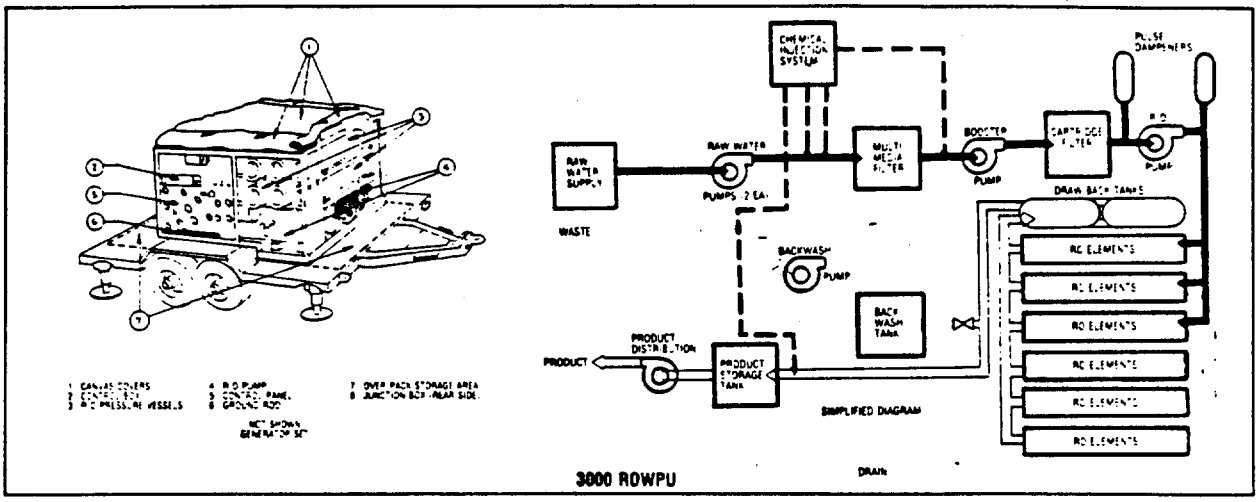
PRODUCT & BACKWASH STORAGE TANKS @ CAPACITY 1500 US GAL (5675L) EA

MECO 600 ROWPU includes all necessary operational tools and test equipment to operate and maintain ROWPU plus chemicals for 200 operating hours. Additional chemical and cartridge filters are available from MECO for extended operational installations.

The system includes: ROWPU system mounted in cubic aluminum skid; RO high pressure pump; pulse dampener; solid state automatic media filter assembly; cartridge filter assembly with spare cartridges; chemical injection system with four pumping heads; booster pump; four membrane/element pressure vessels (loaded); associated piping safeties and controls. OPTIONAL: complete 24V special ROWPU flatbed cargo trailer; Gen Set 30 KW.

Provided as separate items (stored in over pack or fastened to trailer): 2 raw water pumps with frames; covers and strainers; 1 product distribution pump with frame, dispensing nozzle and cover; 1 backwash pump with frame, cover and strainer; three 1500 gal collapsible tank assemblies; 2 storage chests containing tools; test equipment (with instructions); spare fittings; chemicals; miscellaneous hoses; covers for skid; ROWPU manual set (1 operator's, 1 maintenance and 1 lubrication manual).

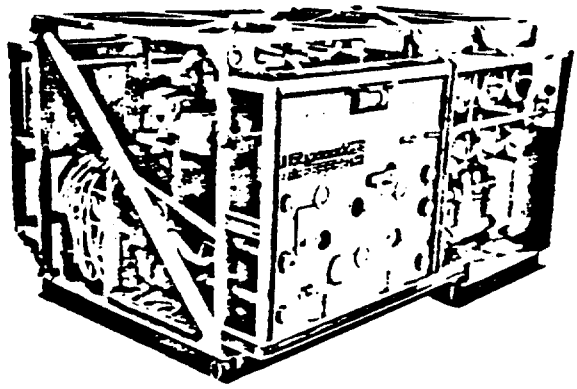
ALL SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.



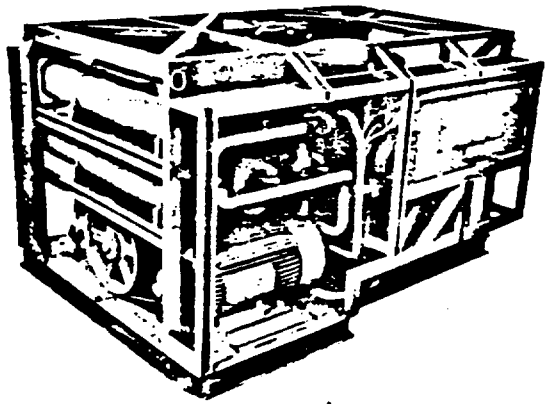
3000 ROWPU

MECO's state-of-the-art technology is evident in the increased capacity 3000 ROWPU. Based on a selection of the most superior performance membrane available and a well proven history, MECO originated a higher pressure and improved capacity RO design. The 3000 GPH ROWPU uses 6 reject staged membranes in a 3:2:1 configuration. This staging coupled with the elevated feedwater pressure of up to 1400 PSIG develops a remarkably greater conversion factor. The higher conversion rate is part of the reason for the 3000 ROWPU's compactness and it's 5X increase in production.

MECO 3000 GPH ROWPU uses essentially the same components and operational aspects as does the 600 GPH ROWPU system. The system is packaged within the same footprint with little weight increase. This enables use of all of the support equipment including the optional trailer, thus keeping the same mobility status which has made the 600 ROWPU popular. The optional 60KW generator is not stored on the trailer. All other characteristics remain the same, except piping and electrical specifications.



3000 GPH ROWPU OPERATOR VIEW



3000 GPH ROWPU REAR VIEW

OPTIONAL TRAINING

MECO offers an optional ROWPU training package on-site or at our training centers in New Orleans, Singapore, Abu Dhabi, and Aberdeen. MECO has an excellent training program. Our reputation as a desalination industry demonstrates this. We emphasize, understand and appreciate the importance of well trained personnel in maintaining and operating these systems.

MECO 3000 ROWPU SPECIFICATIONS

SYSTEM

OUTPUT	TDS ppm	USGPM	LPM	POWER REQUIREMENTS	
PRODUCT FROM SEAWATER	350-1500	33	125	SYSTEM	59.3 KW MAX
PRODUCT FROM BRACKISH	50-500	50	189	VOLTAGE	417 440-3ph
PRODUCT WITH NBC INSTALLED	4-5	33 50	125 189	FREQUENCY	60 HZ
RAW WATER	—	62	235		

PUMPS

PUMP	USGPM	LPM	PRESSURE PSIG	PRESSURE KPa	HP@RPM	MOUNTED MAIN FRM	MOUNTED OWN FRM	MOUNTED CLOSE CPLD
RO HIGH PRESSURE	62	235	1400	9744	60@386	X		—
RAW WATER (2 EA)	62	235	40	278	3@3450		X	X
BACKWASH WATER	120	454	70	483	10@3500		X	X
DISTRIBUTION (PROD)	150	568	73	508	3@3450		X	X
BOOSTER	62	235	34	237	5@3450	X		X

WEIGHTS AND DIMENSIONS

ITEM	LENGTH ft	LENGTH m	WIDTH ft	WIDTH m	HEIGHT ft	HEIGHT m	WEIGHT lb	WEIGHT kg
3000 ROWPU	9.5	2.9	7.0	2.1	5.6	1.7	7800	3538
OVER PACK	—	—	—	—	—	—	2060	934
TRAILER*	19	5.8	8	2.4	3.2	.9	5600	2540
3000 ROWPU & TRAILER~~SEA~~	19	5.8	8	2.4	8	2.4	15460	7012

*MAX TOW SPEED: 50 mph (80 kph); 24V-DC; LUNETTE HITCH HGT 2.4-2.9ft

PRODUCT & BACKWASH STORAGE TANKS @ CAPACITY 3000 US GAL EA

MECO 3000 ROWPU includes all necessary operational tools and test equipment to operate and maintain ROWPU plus chemicals for 200 operating hours. Additional chemical and cartridge filters are available from MECO for extended operational installations.

The system includes: ROWPU system mounted in cubic aluminum skid; RO high pressure pump; pulse dampener; solid state automatic media filter assembly; cartridge filter assembly with spare cartridges; two drawback tanks; chemical injection system with four pumping heads; booster pump; six membrane element pressure vessels (loaded); associated piping safeties and controls.

OPTIONAL: complete 24V special ROWPU flatbed cargo trailer; Gen Set 60 KW.

Provided as separate items (stored in over pack or fastened to trailer): 2 raw water pumps with frames; covers and strainers; 1 product distribution pump with frame, dispensing nozzle and cover; 1 backwash pump with frame, cover and strainer; three 3000 gal collapsible tank assemblies; 2 storage chests containing tools; test equipment (with instructions); spare fittings; chemicals; miscellaneous hoses; covers for skid; ROWPU manual set (1 operator's, 1 maintenance and 1 lubrication manual).

ALL SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

SPECIAL APPLICATIONS

Reverse osmosis is a particularly efficient system, requiring only short duration maintenance periods. Offshore oil exploration, remote construction sites and civilian emergency preparedness are but a few possible uses of such a rugged watermaking system. Automatic ROWPU operation and low MTBF give it exceptional advantages where a limited number of personnel is a problem.

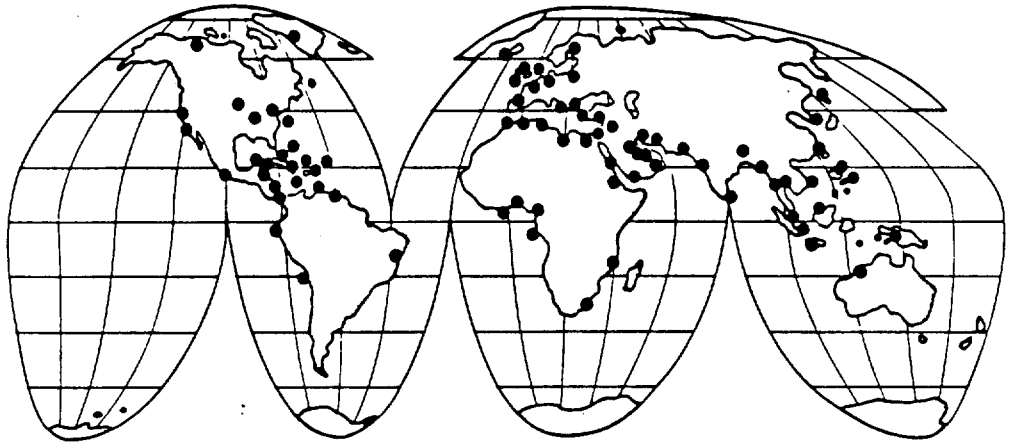
The transportability of MECO's ROWPU frees all types of civil engineering companies remote construction crews from from the problems of uncertain water conditions. In remote areas of the jungle, diseases are still a major concern. ROWPU eliminates concern over waterborne disease in drinking water. Swamps of the jungle become a source of healthy freshwater, capable of sustaining military or civilian personnel with MECO's ROWPU.

MECO BUILDS IT BETTER

Mechanical Equipment Company (MECO) is a desalination corporation. You can depend on us. We have been in the business of water over a half century. Our desalination systems for industry and military applications span the globe. We are not dependent on a particular approach to desalination. We service what we sell no matter what location. Our top level executives are engineering professionals who have over 230 years of combined experience in reverse osmosis, distillation, and heat transfer.

MECO's desalination systems produce constant water stability allowing them to be a candidate for any application where stringent water quality is demanded. Such installations can give a manufacturer better product control where water quality establishes or can destroy batch runs. MECO's special application desalination system designs produce the pyrogen and bacteria-free water required for injection in humans. MECO systems supply water for production of pharmaceutical products and operation of medical facilities. MECO systems meet the demands for electronic and chemical process water specifications. MECO desalination systems offer a new freedom from worries of quality water supply for holiday resort and residence complexes.

MECO offers our customers expertise from standard system designs to one of a kind complex designs. Our state-of-the-art systems are proven. You can buy now with confidence that newer models won't make your system obsolete. Customers who recognize quality and dependability established MECO as a world leader. Over 75% of MECO's business is repeat orders from satisfied customers. We are not over zealous when we say, "MECO builds it better". Our reputation depends on our quality of workmanship and materials. MECO's quality controls and stringent testing procedures insure the MECO ROWPU a quality of excellence.



MECO®

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Cable: MECO
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MECO STOCKING PARTS AGENTS

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UTS MECO
P.O. Box 277
Abu Dhabi, UAE
Telex: 22643 UTS EM
Phone: 824-400

United Kingdom
United Supplies Limited
United House
6 Regent Road
Aberdeen AB1 2NS
United Kingdom
Telex: 739369 PROPUS G
Phone: 581321

Virgin Islands
Mistin, Inc.
P.O. Box 3304
St. Thomas, USVI 00801
Telex: 0030 MISTIN VI
Phone: 776-1186

Singapore
Coastal Equipment
(Singapore) Pte. Ltd.
26 Benoi Road
Singapore 2262
Telex: 35161 COASIN RS
Phone: 861-7133

BULLETIN NUMBER 163-A

REV-MEC-7 87 1M

RECOVERY ENGINEERING, INC.

RECOVERY ENGINEERING, INC.
1204 Chestnut Avenue Minneapolis, MN 55403
(612) 333-6826 TELEX 29-0826
TELEFAX (612) 332-6937

May 17, 1989

VIA FEDERAL EXPRESS
Camp, Dresser, and McKee
1 Cambridge Center
Cambridge, Massachusetts 02142
Attn: Mr. Mike Garland

Ref: Small Scale Water Purification

Dear Mr. Garland:

Per your discussion with Brian Sullivan, I am pleased to send the following information to you:

1. Product Literature
2. Product Specifications for: MROD-35-CS
   MROD-35-CM
3. Technical Bulletin
4. Copies of recent articles on our products
5. Engineering Design Reprint
6. PowerSurvivor Technical Brochure

The product literature enclosed describes the Survivor-35 and the PowerSurvivor. Both units are capable of producing 35 gallons of fresh water per day from seawater or contaminated fresh water. They are designed primarily for use in open seawater applications. Since your particular application will be "coastal" or "in-land", we recommend a modified version of Survivor-35 and PowerSurvivor. The Product Specifications enclosed, MROD-35-CS (Survivor-35) and MROD-35-CM (PowerSurvivor), describe the units that would best suit your application. Both watermakers are equipped with special PreFilters to prevent sand and silt from entering the pump assembly.

Your cost for each unit is as follows:

	Retail	Your Cost
PowerSurvivor (MROD-35-CM)	$2025.00	$1417.50
Survivor-35 (MROD-35-CS)	$1595.00	$1200.00

Mr. Garland, my intention is not to inundate you with information. Hopefully, you won't feel that way. Please take time to review the information enclosed. I'll plan to call you next Monday. In the meantime, if you have any questions, feel free to contact me.

Thank you for your interest in Recovery Engineering.

Sincerely

Barry A. Fisher

Barry A. Fisher
Vice President Sales & Marketing

RECOVERY ENGINEERING, INC.
1204 Chestnut Avenue Minneapolis, MN 55403
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RECOVERY ENGINEERING, INC.

TECHNICAL BULLETIN

SURVIVOR-35™ CS (MROD-35-CS) Product Specification
Hand-operated watermaker for use in coastal applications.

Application: The MROD-35-CS is designed to provide potable water from seawater that contains suspended particles such as sand and silt. In applications where no electrical power exists, the Survivor-35 (CS) acts as a primary water source. Capable of removing 98.6% of most nuclear, biological, and chemical contaminants, it fills a canteen in less than 10 minutes.

Materials of Construction:	Engineering thermoplastics, stainless steels (grades 316 and Nitronic 50), TFC membrane, flexible vinyl tubing
Storage period:	3 years
Inspection period:	After deployment or max. 12 months.
Storage Temperatures:	$-22^{o}F$ - $160^{o}F$ ($-30^{o}C$ - $71^{o}C$)
Feedwater Temperature Range:	$36^{o}F$ - $110^{o}F$ ($2^{o}C$ - $43^{o}C$)

Specifications:

Standard features:	MROD-35 Pump Assembly Standard Handle Assembly BackWashable PreFilter High Output Membrane Element Custom Carrying Case Field Biocide Kit	
Dimensions:		
Width:	3.68 in	9.35 cm
Height:	5.7 in.	14.45 cm
Length: (not including hoses)	22.35 in.	56.75 cm
Weight:	8.4 lb.	3.75 kg.

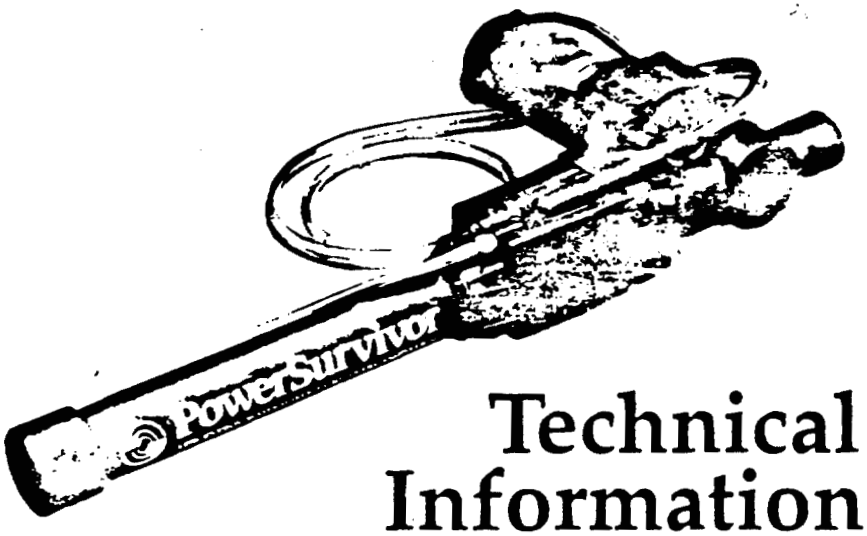
RECOVERY ENGINEERING, INC.
1204 Chestnut Avenue Minneapolis, MN 55403
(612) 333-6828 TELEX 29-0828
TELEFAX (612) 332-6937

Performance Data:

Rate of Water Purification:		
Minimum:	1.4 gallons/hr.	5.3 liters/hr.
Average:	1.7 gallons/hr.	6.4 liters/hr.
Salt rejection		
Minimum:	96.6%	
Average:	98.1%	

Rate and Rejection data are based on the following conditions;
32,000 ppm NaCl, 77 degrees F, 40 strokes per minute.

PowerSurvivor™



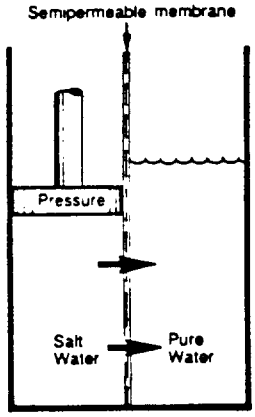
Technical Information

Recovery Engineering was founded in March 1986 to develop products incorporating our proprietary Energy Recovery technology. In December 1986, Recovery won a contract from the U. S. Navy to design, develop, and test a pilot production of 50 hand-operated desalinators. The resulting product, Survivor-35, met and exceeded all the Navy's performance and reliability specifications. Recognizing a need for a low-energy desalinator, Recovery then developed a 12-volt version of this original hand-operated unit. The PowerSurvivor offers the same performance and reliability as the unit developed and tested for the U. S. Navy.

RECOVERY ENGINEERING, INC.
Putting energy back into circulation.

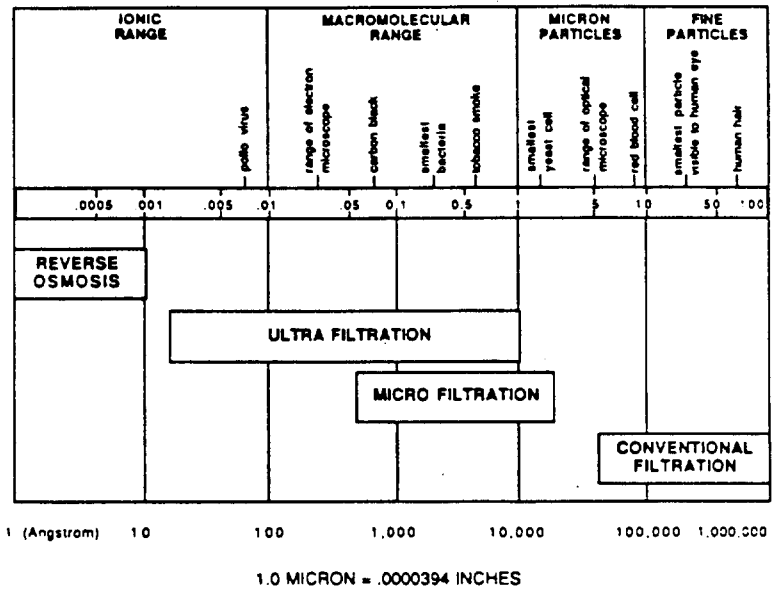
Basic Principle of Reverse Osmosis

The diagram shows the basic principle of reverse osmosis. The semipermeable membrane is a thin film that allows water molecules to pass through but resists the passage of salt molecules. If enough pressure is applied to the seawater side of the membrane to overcome osmotic pressure, and sufficient driving pressure is added, water molecules will pass from the seawater side of the membrane to the pure water side. The salt molecules, however, will not pass through. Typically, the pressure required to desalinate seawater is 800 psi.



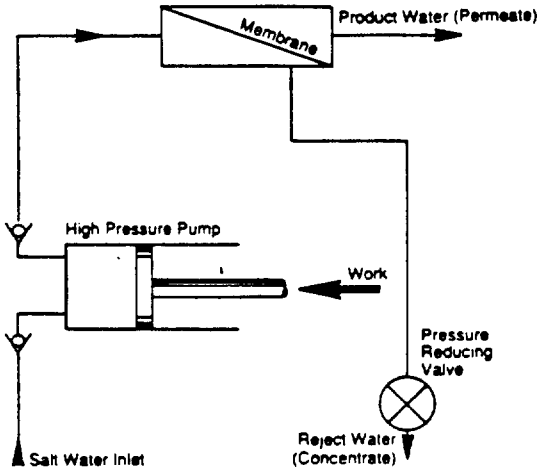
Range of Filtration (Reverse Osmosis vs. Other Methods)

The reverse osmosis membrane is designed as a barrier to dissolved solids, such as a single salt molecule (viruses and bacteria are much larger, and are therefore easily removed by reverse osmosis). The chart illustrates the capabilities of a reverse osmosis membrane.



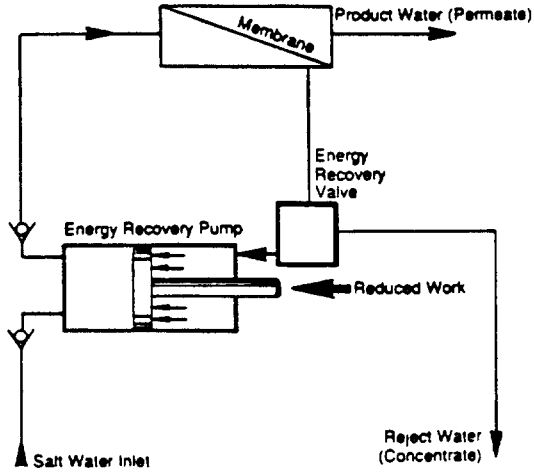
Conventional Reverse Osmosis

The diagram shows a membrane module in a conventional reverse osmosis system. Seawater is forced against the membrane at high pressure, approximately 800 psi. Up to 10% of the incoming seawater is recovered as fresh water. The remaining 90% (reject stream), still under high pressure, passes over a pressure-reducing valve and is dumped overboard.



Reverse Osmosis with Energy Recovery

The diagram shows how a system can be configured to recover and effectively use the energy wasted in conventional reverse osmosis systems. The energy recovery valve directs the reject stream against the back side of the piston, where the energy normally lost is used to help pressurize the seawater.



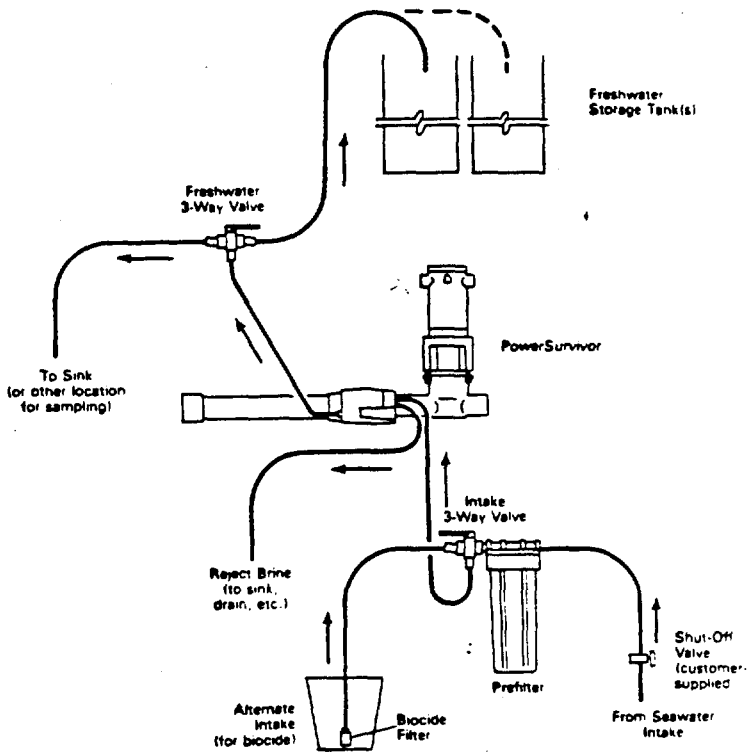
Installation

Use the following criteria in determining a mounting location for the PowerSurvivor:

- Install it as close as possible to the seawater intake. A long feed line will affect the performance of the pump. If the intake or reject line will be longer than 5 ft (1.5 m), use larger-diameter (3/8-in. I.D.) tubing.
- Install the PowerSurvivor close to or below the water line, if possible.
- Provide adequate air circulation to cool the electric motor – the surrounding air temperature should not exceed 113° F (45° C). The area must be free of explosive fumes.
- Mount the unit in an area that will drain to the bilge, as there may be a small amount of leakage from the high-pressure dynamic seals after a period of use.
- While the unit will run properly in any orientation, it is best for the motor and drive housing to be higher than the pump.

Operation

1. Set the intake 3-way valve at the "seawater intake" position. Set the freshwater 3-way valve at the "sink/sampling" position.
2. Turn on the power at the electrical panel (also turn on the remote switch, if used).
3. Once seawater has filled the system and the reject brine stream is clear (no air bubbles), pressure will rise in the unit. Within a few minutes, water will flow from the freshwater line.
4. Continue to divert the water to the sink/sampling line for 3 to 5 minutes, to clear the system of salt that passes through the membrane when not running.
5. Once the unit is producing good water (the product water should not taste salty), turn the 3-way freshwater valve to the storage tank position.
   You can then run it for as short or long a time as you wish. However, because of the 3- to 5-minute start-up time, it is usually desirable to collect fresh water for at least a half hour at a time.



Storage (7 days or longer)

Biological growth will occur in the membrane if seawater is left in the PowerSurvivor for long periods of time. If the unit is used regularly, the growth will not be significant. However, larger amounts will reduce the membrane's performance. If the system won't be used for 7 days or longer, use the following inhibiting procedure to prevent such growth. If operating in extremely hot, humid conditions, follow this procedure every 3 days.

Inhibiting Procedure

Packets of biocide (a chemical to prevent biological growth in the membrane) are provided with the unit. **IMPORTANT:** The biocide contains sodium bisulfite, which is not harmful but may cause an allergic reaction. Be sure to follow the described procedures.

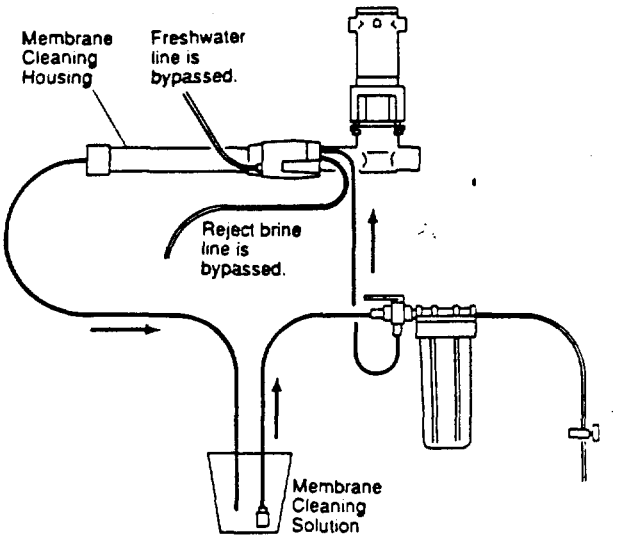
1. Turn the intake 3-way valve to the alternate intake position.
2. Fill a plastic container with about a quart of clean water. Fresh water is preferable, but clean seawater can be used if fresh water is not available.
3. Mix one packet of the biocide with the water until dissolved.
4. Place the alternate intake line into the container, and run the system until all solution has been drawn from the container.
   Continue running the system until as much liquid as possible has been flushed out of the reject line (about 30 seconds).
5. If the system will be shut down for several weeks, or if there is a possibility of freezing temperatures, empty the prefilter housing and remove the cartridge.
6. If seawater was used to mix the biocide solution, repeat the above procedure with fresh water as soon as it is available.

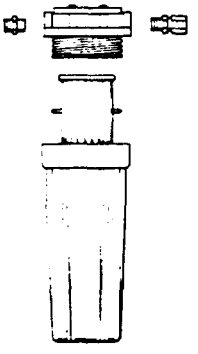
Membrane Cleaning

The membrane does not have to be cleaned regularly. However, even in normal operation it can eventually become dirty or fouled with biological growth and particles which are small enough to pass through the prefilter.

This build-up on the surface of the membrane can cause the freshwater flow rate to be low or the operating pressure to be high. The most likely symptom will be discharge of seawater from the relief valve on the pump body, because of higher-than-normal operating pressure.

Under the above circumstances, the membrane should be cleaned. Use Recovery Engineering's IK4-0200 Membrane Cleaning Accessory, which consists of a special membrane-cleaning housing and an alkaline cleaning agent.





Prefilter Cartridge Replacement

The prefilter protects the pump and membrane from dirt in the incoming seawater. Depending on the amount of use and the condition of the seawater, the prefilter's cartridge may last for months or only days.

If the freshwater flow is reduced to less than 70/cc per min, or if the flow stops because of pump cavitation (pump draws air), the cause is usually a dirty prefilter cartridge. Replace it when the freshwater output decreases.

The life of the filter cartridge can be extended by rinsing occasionally with clear seawater. If the symptoms continue, replace the cartridge.

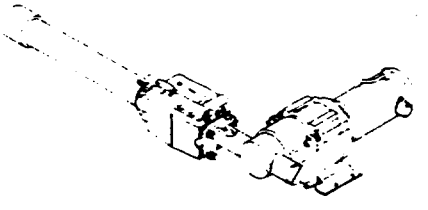
If the unit is used to treat feedwater that has a high bacteria content (for example, swamp water), the membrane should be inhibited daily with a biocide.

Use Recovery Engineering's Cruising Kit IK3-0200, which consists of six prefilter cartridges and ten packs of biocide.

Manual Operation

You can operate the PowerSurvivor by hand if there is an electrical power failure. To do so, replace the electric motor with the manual operating handle (supplied with the unit).

With Motor Attached



With Manual Operating Handle

Performance and Specifications

Fresh water flow (average)	**1.4 gallons/hour**
Purity (constant)	**Removes 98% of salt**
Energy required (average)	**12 volts, 4 amps (hand pump backup)**
Dry weight	**21 lbs (9.5 kg)**
Size	**5.75 x 26.25 x 13.5 in. (14.6 x 66.7 x 34.9 cm)**
Membrane composition	**Thin-film composite**

Recommended Replacement Parts for the Extended Cruise

- Membrane Cleaning Kit IK4-0200
- Repair Seal Kit HP1-103-0300
- Prefilter Cartridge 6-Pack IK1-006-0300
- Biocide Inhibitor 10-Pack IK1-013-1300.

These replacement parts can be purchased together in the Extended Cruising Kit IK3-0201.

Survivor™ Watermakers are Rugged

The U.S. Department of Defense sets the highest quality standards in the world for its products. To receive approval, new products are required to demonstrate their durability by undergoing severe environmental and endurance testing. The Survivor Watermakers were designed to meet these standards. Listed below are just some of the military tests Survivor Watermakers have passed:

- A 65-foot drop test (packed in a raft)
- Exposure to high temperature: alternating between 88° F and 160° F at 12-hour intervals for 30 days
- Exposure to low temperature: alternating between 32° F and -70° F at 12-hour intervals for 30 days
- A vibration test according to military standards
- Storage for 3 years on a Navy ship
- An endurance test to confirm reliability thresholds.

To guarantee that you receive a product capable of meeting these kinds of challenges, each unit undergoes a series of tests before it is shipped. No product leaves the factory unless it has passed each test.

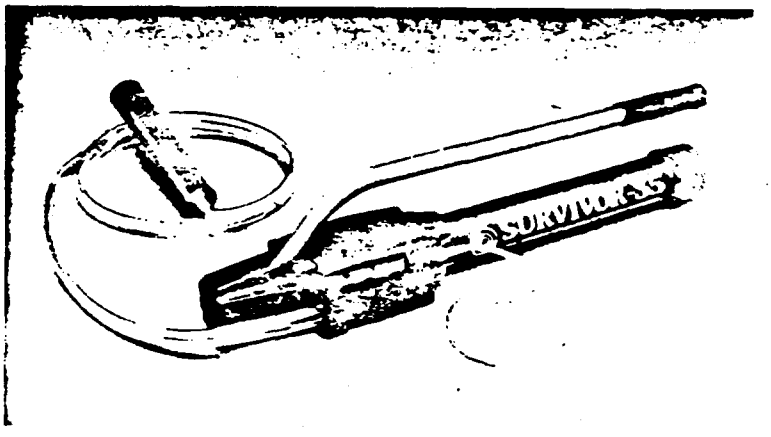
You can depend on the Survivor Watermakers when they are needed.

Hand-Operated Desalinators from Recovery Engineering

Survivor Watermakers are the only hand-operated reverse-osmosis desalinators in the world. Designed, built, and tested to meet rugged world military specifications, they are the state-of-the-art in survival freshwater technology.

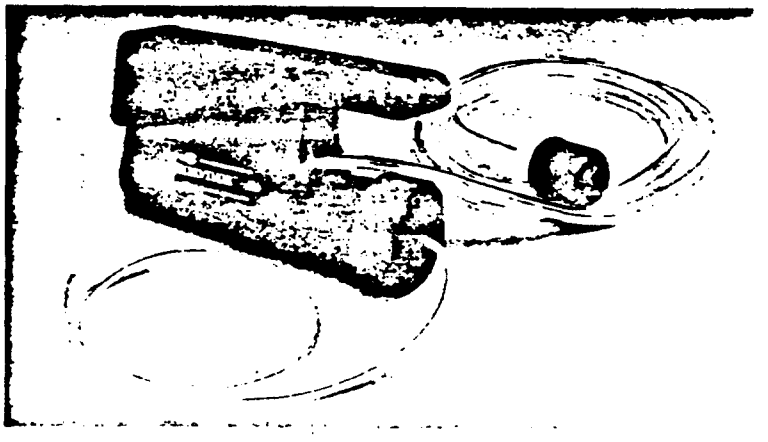
Survivor-35™

- Designed to U. S. Navy specifications
- Produces 1.4 gallons of purified fresh water per hour (average output)
- Weighs less than 7 pounds and is only 22 inches long.



Survivor-06™

- Tested and approved by world militaries for survival equipment
- Produces 2 pints of purified fresh water per hour
- Weighs less than 3 pounds
- Ideal for life rafts and survival packs.



PowerSurvivor, Designed for the Serious Cruising Sailor

Then fatigue set in, which undoubtedly resulted from the constant motion and the continuous compensation the whole body makes. We were caked in salt and sweat, and the relentless two hours on, four hours off watch system seemed to disrupt our lives even to the point of daily hygiene. But then Alan got the new watermaker going. In half an hour, we had enough fresh water to bathe. What a luxury at sea.

from "To the Pacific, Quickly," by Kathy Webb,
***Sailing**, February 1989*

If you think this is an extravagance for a cruising sailboat, consider that in some places you can pay as much as $.50 per gallon for water of questionable quality. Friends of ours who just returned from a cruise in the South Pacific used water from their reverse osmosis unit as trading goods, since high-quality potable water was in such short supply in some areas!

from "Water, Water Everywhere,"
***Practical Sailor**, August 1988*

Up until a few years ago, however, you could only achieve this result with equipment that was bulky, heavy, expensive and required a lot of energy. Luckily for the voyager, that situation has now changed.
Recovery Engineering caught the attention of sailboat voyagers by adding a small 12-volt motor to the Survivor-35. It's called the PowerSurvivor and it draws a miserly 4 amps while creating 1.4 gallons of fresh water per hour. PowerSurvivor weighs under 22 pounds, and takes up less than one cubic foot of space, making it ideal for sail and power yachts.

from "Fresh Water On Demand," by Richard M. Stapleton,
***Ocean Voyager Handbook**, 1989*

For the serious cruising boat, the Survivor-06 is not a luxury. Although the number of castaways who die of thirst will never be known, almost all who survive more than a few days in life rafts report that inadequate drinking water is the biggest threat to long-term survival.

from "Update: The Little Watermaker That Can,"
***Practical Sailor**, December 1988*

PUMPING DE-SALT: Ed Adams, Yachtsman of the Year and Star class world champion, thinks the manual desalinator by Recovery Engineering is the best he's seen.

*from "Experts Choice," **Sail**, January 1989*

RECOVERY ENGINEERING, INC.
1204 Chestnut Ave., Minneapolis, MN 55403
(612) 333-6828 (800) 548-0406
TELEFAX (612) 332-6937

C-8

KATADYN U.S.A., INC.

Katadyn

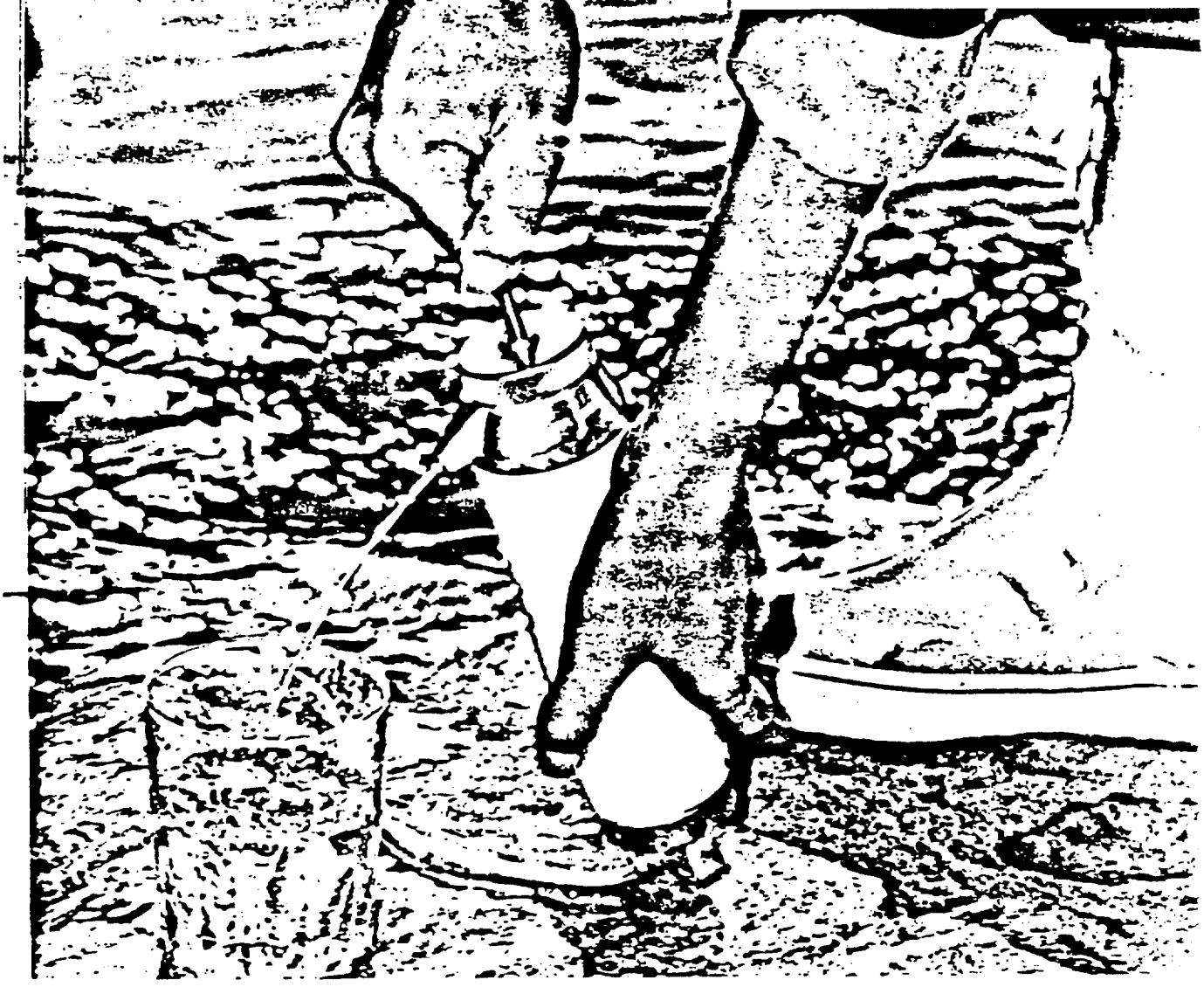
Katadyn Water Purification for trips, emergencies, expeditions **Model PF Pocket Filter**

KATADYN

Katadyn U. S. A., Inc.
Water Purification
3020 N. Scottsdale Roa
Scottsdale AZ 8525
Phone (602) 990-3137
Telex 6835045 maxcr

KATADYN

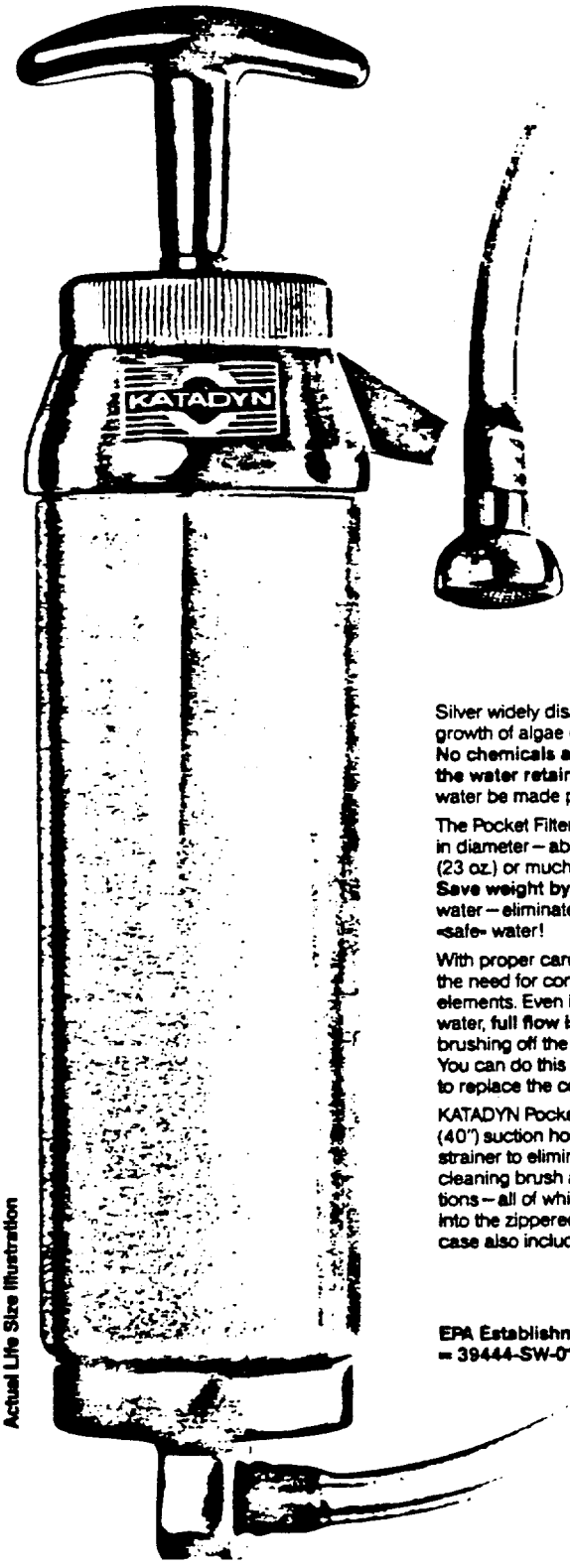
Herbert A. Koelble
Executive Vice President



Instantly drinkable water anywhere with the Katadyn Pocket Filter

Why risk serious illness or death drinking untreated raw water when it's so easy to protect your health with a KATADYN Pocket Filter?

Indispensible for campers, backpackers, fishermen, mountaineers, river runners, globetrotters, missionaries, geologists and workers in disaster areas – **standard issue** with the International Red Cross and the armed forces of many nations – **essential equipment** for survival kits.



Actual Life Size Illustration

Manufactured in Switzerland for over half a century, KATADYN'S Water Filters are based on the proven and **simple mechanical principle of microfiltration** through a 0.2 micron approx. microporous ceramic filter element.

All harmful cocci, bacteria, protozoa, fungi, cysts and parasites are totally removed including the chemically resistant infectious agents of Giardia, the amoebic and shigella dysenteries, and also those causing typhoid, cholera bilharzia and a long list of other dangerous diseases. Larger parasites such as liver flukes are also eliminated.

No chemicals are used in the KATADYN purification process. In contrast to chemical methods based on chlorine and iodine compounds, the effectiveness of microfiltration does **NOT** depend on uncontrollable field variables such as the temperature and acidity of the water, or on the type and quantity of dissolved or suspended mineral or organic matter.

Neither is there any question of how much chemical to use, how long a contact time you need, how long and how vigorously you must stir the water to make it safe, or whether the chemicals have lost potency with time or exposure to heat or moisture.

And, unlike chemical methods, KATADYN Pocket Filters **work equally well with turbid water** heavily laden with silt or algae and **will clarify the water** as well as disinfecting it.

The KATADYN Pocket Filter **has a built-in pump** to develop the pressure needed for rapid filtration. With little effort you can produce **3/4 liter (quart) per minute** of safe drinking water.

Silver widely dispersed and fixed throughout the ceramic element prevents the growth of algae or bacteria into the ceramic, keeping it free of contamination. **No chemicals are added** to the purified water and none are removed – **the water retains its natural mineral content.** Neither will seawater or brackish water be made potable as no salts are removed.

The Pocket Filter is **compact** – only 250 mm (10") long and 50 mm (2") in diameter – about the size of a two-cell flashlight. **Weighs only 650 grams** (23 oz.) or much less than a one liter (quart) canteen of water. **Save weight by carrying a Pocket Filter** and using available raw water – eliminate the burden of bringing along large stocks of «safe» water!

With proper care, your Pocket Filter **will last many years** without the need for consumable chemicals or disposable filter elements. Even if it should plug up when pumping turbid water, **full flow is quickly restored** by wiping or brushing off the raw water side of the filter element. You can do this hundreds of times before you need to replace the ceramic filter element.

KATADYN Pocket Filters come with a 100 cm (40") suction hose fitted with an intake strainer to eliminate coarse debris, a cleaning brush and user instructions – all of which packs neatly into the zippered soft carrying case also included.

EPA Establishment = 39444-SW-01

Certificates of the effectiveness of KATADYN Water Filters on file at the factory include:

Swiss Red Cross, Geneva
Swiss Tropical Institute, Basle
University of Zurich
Pasteur Institute, Lille
Harvard University, Cambridge
University of Costa Rica, San José
National Institute of Hygiene, Lima
Haffkine Institute, Bombay
Harcourt Butler Institute, Rangoon
Public Health Department, Sydney
Bureau of Health, Manila
Africa Inland Mission, Kampala
Ministry of Health, Cairo
Ross Institute of Tropical Medicine, London

KATADYN

Katadyn U.S.A., Inc.
Water Purification
Warehouse + Service-Center
3020 North Scottsdale Road
Scottsdale, Arizona 85251

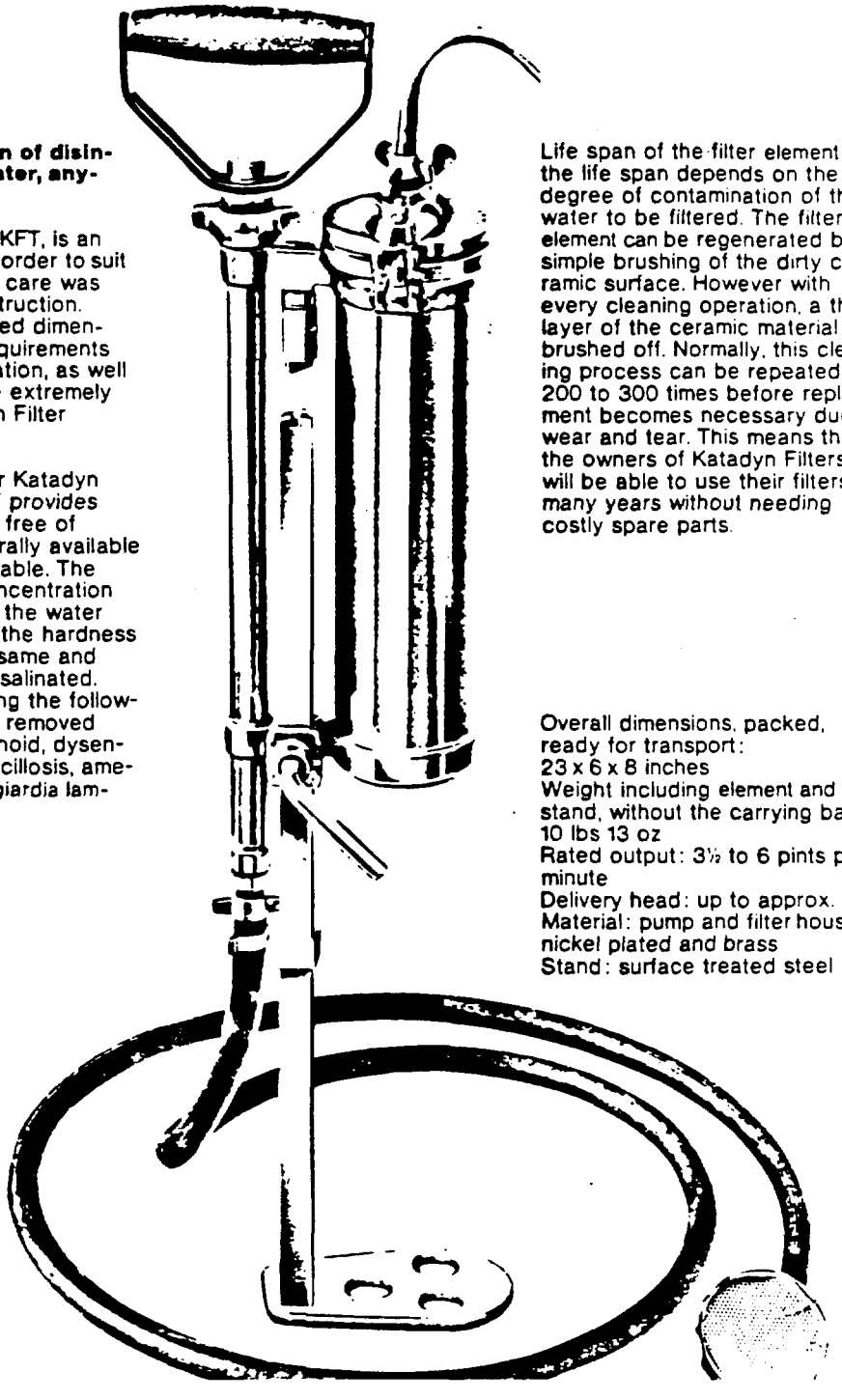
Katadyn handpump filter for the disinfection of water Type KFT

KATADYN

Instantly 2-3 l/min of disinfected drinking water, anywhere.

Katadyn filter, type KFT, is an appliance, which in order to suit its purpose, special care was taken over its construction. Owing to the reduced dimensions, the space requirements are small and operation, as well as maintenance are extremely simple. Use Katadyn Filter Element No 4.

As with all the other Katadyn filters, the type KFT provides clear, filtered water free of bacteria. Thus naturally available water is made drinkable. The mineral and salt concentration and composition of the water remain unchanged, the hardness of the water is the same and sea-water is not desalinated. All organisms causing the following diseases will be removed from the water: typhoid, dysentery, cholera, colibacillosis, amebiasis, bilharciosis, giardia lambliasis, etc.



Life span of the filter element: the life span depends on the degree of contamination of the water to be filtered. The filter element can be regenerated by simple brushing of the dirty ceramic surface. However with every cleaning operation, a thin layer of the ceramic material is brushed off. Normally, this cleaning process can be repeated 200 to 300 times before replacement becomes necessary due to wear and tear. This means that the owners of Katadyn Filters will be able to use their filters for many years without needing costly spare parts.

Overall dimensions, packed, ready for transport:
23 x 6 x 8 inches
Weight including element and stand, without the carrying bag:
10 lbs 13 oz
Rated output: 3½ to 6 pints per minute
Delivery head: up to approx. 13'
Material: pump and filter housing nickel plated and brass
Stand: surface treated steel

Katadyn U.S.A., Inc.
Water Purification

3020 North Scottsdale Road
Scottsdale, Arizona 85251

Phone: (602) 990-3131
Telex: 6835045 maxch

Longitudinal cut of a self-disinfecting Katadyn Filter Element No. 4

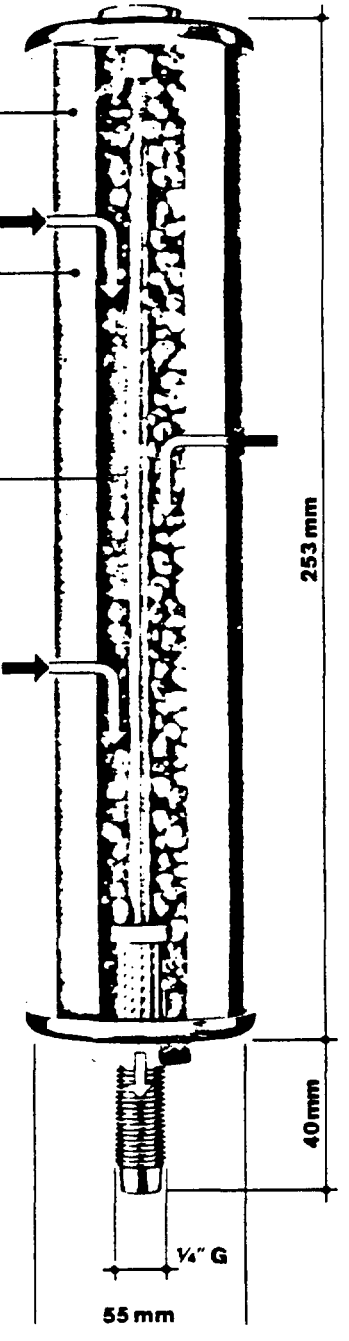
1
Ceramic tube with extremely fine pores
– retains all suspended matter and bacteria in raw water on the surface of the filter element

2
finely dispersed Katadyn silver within the ceramic
– prevents bacteria from growing through the pores of the element
– keeps the ceramic body disinfected continuously

3
Katadyn silver quartz filling
– avoids internal bacteriological contamination from the outlet side

➡ unfiltered water

⇨ disinfected water



The Katadyn filter element is an ingenious design of scientifically tested ceramic of unique submicron capillary structure.

Contamination of Katadyn's filter ceramic by harmful bacteria is prevented through bacteriostatic silver. This is finely dispersed and fixed throughout the ceramic material by Katadyn's proprietary manufacturing process.

No chemicals are used for the disinfection of the water.

Katadyn Filters have unique multiple safety features and **are the only ones that prevent dangerous disease-causing germs from growing through the ceramic body, even after years of use!**

Tests confirming the effectiveness and reliability of Katadyn filters have been conducted by many university, government and independent laboratories.

Registerd among others by:
United States Environmental Protection Agency
EPA Reg. N° 39444-6
EPA Est. N° 39444-SW-01

4/56 Printed in Switzerland

C-9

CHLOR-FLOC

CONTROL CHEMICALS

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Manufacturers and distributors of Con-Chem quality products
Vervaardigers en versprelders van Con-Chem gehalte produkte

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Tel (011) 786-7160/9
Fax (011) 885-1300

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BY FAX

NUMBER OF PAGES INCLUDING THIS PAGE ....5..........

If you do not receive all the pages in perfect condition please inform this office at once.

TO	:	DATE	: 16 June 1989
ATT	: MR. MIKE GARLAND	SUBJECT	: CHLOR-FLOC
		REF	: L. BUCHAN

Dear Mike,

Attached is a product summary. If you require further information please advise.

The summary is just over three pages because if printed in smaller type it could be smudged by Fax transmission.

If it is imperative that you have a more concise summary I will gladly oblige. However, I feel that because of the novelty of the product a bit of elaboration is required.

Yours faithfully

Leon

DR. LEON BUCHAN
TECHNICAL DIRECTOR

Directors/Direkteure:
T.W.V. Buchan M.Sc. (Chem.) (Managing/Besturende) L. Buchan D.Sc. (Microb.)

CHLOR FLOC
EMERGENCY DRINKING WATER
WATER PURIFICATION AND GERMICIDAL TABLET
E.P.A. Reg. No. 57425-1

P R O D U C T I N F O R M A T I O N

CHLOR-FLOC TABLETS are intended for the clarification and disinfection of polluted or suspected water, to make it bacteriologically safe for drinking when treated as directed. Recommended for use by the military during field exercises, and for the general public for use in situations where municipally treated water is not available or where the available water is suspected of being polluted.

PRODUCT CONCEPT

The problems of providing the individual with safe and aesthetically acceptable drinking-water under adverse conditions are well documented. Extensive research has been conducted concerning the provision of a disinfectant tablet which will render global waters safe of infective agents and also be acceptable to the user. These efforts have not been successful and led to the development of physical-chemical filtering devices. However, because of clogging, size of equipment, susceptibility to damage and possible failure at the time when water might most be needed, none of these devices have been found acceptable for disaster situations.

The abovementioned research and developments were undertaken because it was considered that because of lack of expertise and equipment, it is not practically feasible for the individual to purify water by the established processes of coagulation, flocculation, sedimentation and chlorination.

The CHLOR-FLOC tablet is a unique composition which enables individuals to purify and disinfect water within minutes, without the requirement of expertise or equipment.

Besides the primary purpose of providing the individual with a non-infective water, CHLOR-FLOC produces with extremely little effort a good quality water from polluted sources. This has the advantage that the individual prefers to use the tablet because visually a better water is obtained. Furthermore, the product makes water available for use which would otherwise be considered unacceptable even if iodine or chlorine were added to it.

EPA - REQUIREMENT FOR WATER PURIFIERS

Because of the variable nature of pick-up water, the EPA published a new Protocol for the testing of water purifiers in 1986. This Protocol requires the testing of water purifiers in a simulated worst case water. This water is defined by the EPA and contains salts,

humic substances and colloidal material. Tests must also be conducted at different pH and temperature values. CHLOR-FLOC IS THE ONLY PRODUCT WHICH HAS FULFILLED THE REQUIREMENTS OF THE PROTOCOL AND WAS ISSUED AN EPA REGISTRATION IN 1989.

PRINCIPLE OF CHLOR-FLOC

The CHLOR-FLOC composition is a unique blend of water purification chemicals which rapidly:

(i) removes visible pollutants from water, thereby yielding a crystal clear water within minutes;

(ii) removes most of the non-visual pollutants from water;

(iii) kills disease-causing organisms in the water.

CHLOR-FLOC thus not only renders water safe from germs but, because it purifies water, it also makes water which would otherwise be considered unacceptable, available for use.

CHLOR-FLOC CHEMISTRY

ACTIVE INGREDIENT:

Sodium dichloro-s-triazinetrione 2,5%

INERT INGREDIENTS 97,5%

(Provides 1,4% available chlorine)

CHLOR-FLOC is a 600 mg tablet composed of a flocculant composition which contains chlorine in the form of triazine-trione. CHLOR-FLOC tablets dissolve rapidly in water and have been found to clarify a wide variety of global water, to the extent that it seems to be universally effective. No equipment or expertise is necessary and water can be purified in a canteen, bottle or by merely making a hole in the ground adjacent to a raw water source. Simple stirring of the water causes the water to coagulate and within 5-min a cohesive sludge is formed which rapidly separates from the water or can be removed by straining through a piece of cloth.

It is doubtful whether any other field pick-up purification chemical or device has been tested so stringently and passed as many tests as CHLOR-FLOC. The uniqueness of the tablet is the ability to rapidly clarify global water. The effectiveness of the CHLOR-FLOC tablet is due to the fact that -

* water is clarified
* water is acidified, i.e. chlorine is present as hypochlorous acid
* tablet yields 9 mg/litre free available chlorine in distilled water.

SAFETY DATA

All components are approved water treatment chemicals or food additives and fall with permissible levels as defined by the EPA and/or FDA.

EFFICACY

CHLOR-FLOC contains a combination of flocculating and coagulating agents which promtoes rapid formation of a sediment in the treatment water. Pollutants, in the form of gross organic matter and microscopic particles adhere to the sediment by the action of the flocculating and coagulating agents. The sediment with the entrapped pollutants are removed from the clarified water by straining through a piece of cloth or by leaving a few minutes to allow settlement of the sediment. After clarification of the water by separating sediment from the treated water, the chlorine released by the active ingredient is then free to kill bacteria, viruses, and other harmful micro-organisms which are not removed with the sediment.

(a) **Germicidal Efficacy**

CHLOR-FLOC has been shown to be effective against the most resistant water-borne organisms, such as enteric bacteria, amoebic cysts, viruses and cysts of *Giardia lamblia*.

(b) **Removal of Chemical Pollutants**

CHLOR-FLOC sludge has powerful adsorptive properties. Tests on the removal of potentially harmful chemicals are limited, the most significant tests conducted to date are the removal of -

1. Arsenic
   Before treatment 20 mg/litre
   After treatment not detectable
2. Parathion
   Before treatment 5µg/litre
   After treatment 0,07µg/litre

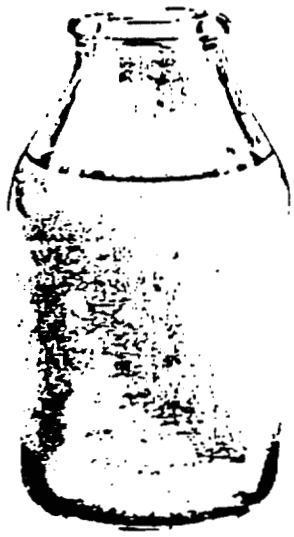
PACKAGING

Tablets are packaged hermetically sealed in paper-foil-polythene laminate. Each package of CHLOR-FLOC contains ten tablets, enough to treat 10 litres (11 quarts) of polluted water. One 600 milligram tablet provides 1,4% available chlorine, and enough flocculating agent for the CLARIFICATION AND DISINFECTION OF 1 LITRE (1,10 QUARTS) OF WATER FROM POLLUTED SOURCES AT TEMPERATURES OF 72° Fahrenheit (22°C). At 41°F (5°C) two 600 milligram tablets will provide 2,8% available chlorine for the same purpose.

STABILITY

Tablets which were stored on a laboratory shelf for one year were subjected to a one month stability test under various conditions ranging from 4°C to 55°C. The results indicate that the product is stable with a shelf-life of more than two years under normal storage conditions.

AVAILABLE DRINKING WATER POLUTED?



Clear, tasty disinfected water is always at hand ...If you remember your Chlor·Floc Watermaker tablets.

Chlor-Floc tablets separate pollutants from water

Raw pollutants settle

Filtration yields a crystal clear disinfected water six minutes after addition of a Chlor-Floc Tablet

Easy to use rapid acting Chlor-Floc are the only drinking water tablets in the world that Clarify and Disinfect polluted water. A water treatment plant in a single tablet.

Authoritative laboratory tests have confirmed that the treatment of heavily polluted waters with Chlor-Floc yields water of bacteriological purity equivalent to that required for potable water in cities

Chlor·Floc the Watermaker

CHLOR FLOC — CHLOR FLOC
EMERGENCY DRINKING WATER TABLETS

PROVEN EFFECTIVE AGAINST GIARDIA LAMBLIA

CONTROL CHEMICAL
D/B/A DEATRICK AND ASSOCIATES INC.
1013 E. TAYLOR RUN PKWY
ALEXANDRIA, VA 22302

Deatrick & Associates, Inc.
1013 E. TAYLOR RUN PARKWAY
ALEXANDRIA, VA 22302

(703) 548-6057 OFFICE
(703) 548-6475 TELEFAX

31 May 1989

Dear Mike,

In reference to our telephone conversation this afternoon, I am enclosing a copy of our video tape which visually presents the Water Tablet and the Watermaker Flocculation Powder.

We have been working with the Army on the tablet for about four years. The bureauracracy is not too swift, however, yesterday I was visiting the Quartermaster School at Ft. Lee, Virginia and it now appears that it now "when" rather than "if". Commander Gray was in touch with Office Joint Chiefs of Staff last year and they referred him to us. Three points of contact within the Army that are actively engaged in acquiring Chlor-Floc are :

Colonel Michael T. Murphy	OJCS(J-4)	(202) 697-1064
Major Scott Haas	QM (Combat Development)	(804) 734-3238
Colonel Kenneth W. Vos	Office of Army Surgeon General	(703) 553-2559

The tablet is a single unit item whereas the Watermaker as seen in the video is a modular system which can be applied for any desired volume (1000 gallons/ hour - 5000 gallons/ hour). The Watermaker as a modular system is constructed in such a manner that it can be loaded on a trailer and moved from one location to another.

If there is an interest in these items, Dr. Buchan shall be more than happy to meet with you at your convenience. He shall be in the States until about 14 June and is quite wiling to discuss in detail each of these items at your office in Boston.

Sincerely,

Eugene Deatrick

Eugene P. Deatrick
President

Enclosures: Video Tape (Watermaker)
EPA Registration/Chlor-Floc Documentation

Mr. Michael Garland
Camp, Dresser and McKee
1 Cambridge Center
Cambridge, MA 02142